NUREG-1183

Nonradiological Groundwater Quality at Low-Level Radioactive Waste Disposal Sites

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WASHINGTON, D. C. 20555

APR 17 1986

TO THE READERS OF NUREG-1183, "NONRADIOLOGICAL GROUNDWATER QUALITY AT LOW-LEVEL RADIOACTIVE WASTE DISPOSAL SITES"

Commercial low-level radioactive waste is regulated by the U.S. Nuclear Regulatory Commission (NRC) and NRC Agreement State programs under the Atomic Energy Act, as amended. Hazardous wastes are regulated by the U.S. Environmental Protection Agency (EPA) and authorized states under the Solid Waste Disposal Act and the Resource Conservation and Recovery Act (RCRA) as amended. In addition to radiological properties, certain low-level wastes may also contain chemical constituents that would classify the waste as hazardous under EPA regulations. These wastes have been referred to as "mixed wastes."

During the course of the NRC 10 CFR Part 61 rulemaking on land disposal of low-level radioactive waste, questions emerged regarding the potential hazards presented by the nonradiological components of low-level waste. This report, "Nonradiological Groundwater Quality at Low-Level Radioactive Waste Disposal Sites," describes the levels of nonradioactive hazardous chemical constituents in samples from several groundwater monitoring wells at two low-level waste disposal sites. These data are related to radiological water quality and the disposal history of the site and vicinity. In addition, this report discusses previously collected data from these two sites as well as other LLW disposal facilities.

The primary nonradiological contaminants observed in groundwater at LLW sites are organic solvents. Concentrations of several organics were above proposed drinking water levels at the Sheffield LLW site (nonoperating), while only trace levels (μg/ℓ) of a few man-made chemicals were detected at the Barnwell LLW site (operating). At Sheffield, high concentrations are observed both onsite and offsite in an area of elevated tritium concentration. Organic chemicals and TOC (total organic carbon) have previously been detected in elevated concentrations in groundwater samples from these sites and in trench sump samples from two other LLW sites. Hydrocarbons associated with petroleum products were detected at both sites in this study.

Other potential hazardous constituents identified in an NRC study, "An Analysis of Low-Level Wastes: Review of Hazardous Regulations and Identification of Radioactive Mixed Wastes" (NUREG/CR-4406), were at or below detection limits or at background levels in collected groundwater samples. These constituents include lead, chromium, toluene, and xylene. The latter two are associated with liquid scintillation media. Toluene has previously been detected in groundwater and trench sump samples from Barnwell and other sites, but concentrations decrease over short time periods indicating a relatively brief persistence in groundwater.

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In addition to the studies noted above, NRC is pursuing several other investigations. A draft analysis of mixed waste management options, "Management of Radioactive Mixed Wastes in Commercial Low-Level Wastes" (NUREG/CR-4450), was recently published for public comment. The purpose of this analysis is to identify a range of management options for segregating, treating and disposing of mixed wastes, and to describe current generator management practices. Guidance on environmentally sound, cost effective management methods will be developed following consideration of comments. Copies of this and other NUREG reports on mixed waste may be obtained from the sources identified on the inside cover of this document.

The NRC will continue to provide information on potential mixed wastes. We are also interested in additional information and data which waste generators, the waste management service industry, or other agencies may offer on types and amounts of mixed wastes and improved management practices. Specific questions regarding this report may be directed to Mr. Dan Goode, Hydrogeologist, U.S. Nuclear Regulatory Commission, 623SS, Washington, DC 20555.

RE Browning
Robert E. Browning, Director
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II

ABSTRACT

The NRC is investigating appropriate regulatory options for disposal of low-level radioactive waste containing nonradiological hazardous constituents, as defined by EPA regulations. Standard EPA/RCRA procedures to determine hazardous organics, metals, indicator parameters, and general water quality are applied to samples from groundwater monitoring wells at two commercial low-level radioactive waste disposal sites. At the Sheffield, IL site (nonoperating), several typical organic solvents are identified in elevated concentrations in onsite wells and in an offsite area exhibiting elevated tritium concentrations. At the Barnwell, SC site (operating), only very low concentrations of three organics are found in wells adjacent to disposal units. Hydrocarbons associated with petroleum products are detected at both sites. Hazardous constituents associated with previously identified major LLW mixed waste streams, toluene, xylene, chromium, and lead, are at or below detection limits or at background levels in all samples. Review of previously collected data also supports the conclusion that organic solvents are the primary nonradiological contaminants associated with LLW disposal.

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EXECUTIVE SUMMARY

The Resource Conservation and Recovery Act (RCRA) mandates the Environmental Protection Agency (EPA) to regulate the management of hazardous substances with the exception of source, special nuclear, and byproduct materials regulated under the Atomic Energy Act. Provisions in the regulations promulgated under the two acts have created uncertainty regarding the roles and responsibilities of NRC and EPA in regulating disposal of potentially hazardous nonradioactive constituents mixed with commercial low-level radioactive wastes (LLW). As a part of NRC's program to address this issue, groundwater samples from two LLW disposal sites have been analyzed for nonradiological constituents.

This report describes the levels of nonradioactive hazardous chemical constituents in samples from several groundwater monitoring wells at the Sheffield, IL and Barnwell, SC low-level radioactive waste disposal sites. These data are related to radiological water quality and the disposal history of the sites and vicinities. In addition, this report discusses previously collected data from Sheffield and Barnwell, as well as from the West Valley, NY, and Maxey Flats, KY disposal sites.

The primary nonradiological contaminants observed in groundwater at LLW sites are organic solvents. Significant concentrations of several organics are detected at the Sheffield site while only trace levels of a few man-made organics are detected at Barnwell. At Sheffield, high concentrations are observed both on and off site in an area of elevated tritium concentrations. Organics and TOC (total organic carbon) have previously been detected in elevated concentrations in groundwater samples from these sites and in trench sump samples from two other LLW sites. Hydrocarbons associated with petroleum products are detected at both sites in this study.

Other potential mixed waste constituents identified in an NRC study are at or below detection limits or at background levels in collected groundwater samples. These constituents include lead, chromium, toluene, and xylene. The latter two are associated with liquid scintillation media. Toluene has previously been detected in groundwater and trench sump samples from one of the two sites and other sites, but concentrations decrease over short time periods indicating a relatively brief persistence in groundwater.

These data indicate that organic solvents, typical groundwater contaminants at any solid waste disposal facility, hazardous or not, are also found in groundwater at LLW sites. Contamination from lead, chromium, toluene, and xylene, which have previously been identified as potential mixed waste constituents in LLW, is not indicated by groundwater samples in this study.

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I. INTRODUCTION

A. Background

The Resource Conservation and Recovery Act (RCRA) mandates the Environmental Protection Agency (EPA) to regulate the management of hazardous substances with the exception of source, special nuclear, and byproduct materials regulated under the Atomic Energy Act. Provisions in the regulations promulgated under the two acts have created uncertainty regarding the roles and responsibilities of NRC and EPA in regulating disposal of potentially hazardous nonradioactive constituents mixed with commercial low-level radioactive wastes (LLW). As a part of NRC's program to address this issue, groundwater samples from two LLW disposal sites have been analyzed for nonradiological constituents.

It has been recognized for some time that fuel cycle and nonfuel cycle LLW may contain nonradiological hazardous constituents (e.g., General Research Corporation 1980, their Table 3-2; Lohaus and Johnson 1983). As part of an NRC-funded study, Bowerman and others (1985) surveyed LLW generators and identified three waste streams which should be tested to determine if they constitute "hazardous waste" as defined by EPA regulations (40 CFR Part 261). These waste streams were organic liquid wastes, lead shielding and container wastes, and light-water-reactor process wastes containing chromium. The organic liquid wastes reported in the survey were scintillation liquids and vials (73% by volume), laboratory liquids (18%), and miscellaneous solvents (9%) (Bowerman et al. 1985). Toluene and xylene are the primary organic chemical components in scintillation vials.

Based on their predominance in the generated LLW, it would be expected that if organic chemicals are migrating from LLW disposal units, then toluene and xylene would be the most likely organics to be detected above background concentrations. Likewise, lead and chromium are the hazardous metals most likely to appear in the vicinity of the disposal units. These hypotheses, however, do not consider other factors which effect the migration, persistence, and fate of solutes in groundwater including biodegradation, adsorption, and volatilization. All of these processes are controlled by site-specific geochemical conditions which may vary with time and with location.

This preliminary sampling study has been carried out to investigate the nonradiological groundwater quality at actual LLW disposal facilities. These facilities serve as full-scale experiments of the effect of LLW disposal on groundwater. Although it is very unlikely that any future site will exhibit identical hydrogeologic and geochemical characteristics, the results of this sampling should indicate the order of magnitude of minimum containment performance of LLW disposal facilities using past and current shallow land burial technology. Future sites which meet the site suitability requirements of 10 CFR Part 61 should exhibit even less groundwater contamination.

Available data from the sites not chosen for this sampling program are summarized below in this section. The procedures and results for sampling at the Sheffield site are presented and discussed in Section II. Section III describes results for the Barnwell site. Section IV summarizes the results of the preliminary sampling program and presents conclusions based on these and previous efforts.

B. Available Information from Disposal Sites

Groundwater and trench water from the West Valley, New York, and Maxey Flats, Kentucky, LLW disposal sites have previously been analyzed for nonradiological constituents. Trenches at these humid sites have accumulated water due to the low permeability of site soils in which the disposal units are located and due to inadequate trench covers (Clancy et al. 1981). Under NRC's regulation for LLW disposal (10 CFR Part 61), new sites must be well-drained and trench covers must minimize infiltration to eliminate this problem. Because these sites do not meet Part 61 siting criteria, they are not considered to be representative of current disposal technology. For this reason, these sites were not included in the present preliminary sampling program. Nonetheless, review of previous sampling results at these sites provides relevant background to the leaching of waste components at LLW disposal sites.

Clancy and others (1981), Dayal and others (1984), and Kirby (1984) summarize the characteristics and performance of the Maxey Flats LLW disposal facility. Zehner (1983) presents the hydrogeology of the site. Disposal units at the Maxey Flats site were constructed in a fractured shale of low hydraulic conductivity. Water which infiltrates through the compacted soil covers percolates out of the trench only very slowly. The microbial degradation of organic materials in the waste and the long residence time of trench water has resulted in elevated concentrations of inorganic, organic, and radioactive constituents which leach from the waste. Anoxic conditions have developed in the trenches due to biodegradation of organic materials.

Dayal and others (1984) summarize geochemical studies performed at Maxey Flats by Brookhaven National Laboratory (BNL) for NRC from 1976 to 1981. BNL analyzed trench and groundwater samples for cations, anions, radionuclides, and organic constituents. However, trace metals, including lead and chromium, were not included in these studies. Organic compounds identified in trench leachates included: toluene, xylene, naphthalene, cresol, phenol, cyclohexanone, and methyl isobutyl ketone. Dioxane was also detected in the trenches although the concentration was not quantified (Czyscinski and Weiss 1981; Weiss and Colombo 1980). Previously, BNL detected trichloroethane in trench water (reported by General Research Corporation 1980). Of these organics, toluene was detected in the highest concentrations with 9.5 mg/l in trench 19s in 1979 (Dayal et al. 1984). High concentrations of toluene were consistently found in trench leachates from Maxey Flats. Xylene was also often detected, although at order of magnitude lower concentrations. BNL also sampled two groundwater monitoring wells near trench 19s. Weiss and Colombo (1980) detected dioxane, toluene, xylene, naphthalene, and other organics in well UB1 (November 1977), and dibutyl phthalate and triphenyl phosphate only in well UB1-A (May 1978). In November 1979, ethylene glycol, diethylene glycol, polyglycol, and dioxane were detected, but not quantified, in well UB1-A. Well UB1 was not sampled. Concentrations of dissolved organic carbon in trenches decreased from 1976 to 1979 (Czyscinski and Weiss 1981).

Kirby (1984) presents more recent results (1981-1982) from sampling at Maxey Flats by Pacific Northwest Laboratory (PNL). Toluene was detected in trench 27 in April 1981 but not in July 1982. Toluene was not detected in trench 19s in 1982, in contrast to results reported by Dayal and others (1984). Likewise, toluene was detected by PNL in monitoring well W2NA in May 1981 but not in August 1981 or June 1982. Pyridine, nicotine, barbital, pentobarbital, and other constituents were also detected in groundwater wells. The latter two of these chemicals are barbiturates and are probably associated with disposal of radiopharmaceuticals (Kirby 1984).

PNL (Kirby 1984) did not detect many of the constituents identified by Dayal and others (1984) from samples taken in 1976 and 1979. These results may indicate improved cover performance and subsequent reductions in leaching, or removal of the source due to leaching (and ceased burial). Based on these data, toluene constitutes the primary hazardous organic constituent detected in trench water and groundwater at the Maxey Flats site. Toluene concentrations may have returned to background levels due to transient effects since the cessation of disposal operations.

The New York State Department of Health and BNL sampled trench water at the West Valley, New York, commercial LLW disposal site. This site is located adjacent to a dormant nuclear fuel reprocessing plant and to a DOE managed disposal facility where high-level wastes were buried and where an immiscible kerosene plume was detected in groundwater wells (Herbes and Clapp 1984). As above, no analyses appear to have been performed for trace hazardous metals, including lead and chromium. Trench water samples from the commercial LLW site were analyzed for organic constituents.

The results of the New York State sampling and analysis for organics in trench water from the West Valley commercial LLW site were summarized (Husain et al., as reported by General Research Corp. 1980):

> The major components of the dichloromethane fraction were cresol, aromatic ketones, and xylyl butanoic acid, whereas the hexane fraction was dominated by phthlate ester and tributyl phosphate. Many constituents in the hexane fraction were likely derived from buried cleaning agents, germicidal cleansers, surfactants, and paints. The aromatic ketones, xylyl butanoic acid, and humic acid residues were probably naturally occurring breakdown products of living matter.

The organic chemicals and concentrations identified in the trench waters were considered to be "remarkably similar" to water samples from sanitary landfills in Pennsylvania, Illinois, and Wisconsin (General Research Corp. 1980).

BNL collected water samples from 6 trenches at the West Valley site (Weiss and Colombo 1980). Concentrations of dissolved organic carbon increased for 4 of these trenches between November 1977 and October 1978. Organic chemicals identified in trench water included toluene, phenol, cresol, dioxane, and naphthlene. The concentration of toluene increased at all trenches from November 1977 to October 1978 with a maximum concentration of 25 mg/l. Cresol was also present in high concentrations and phenol concentrations were high in several samples. Xylene, however, was not detected in any trench water samples (Weiss and Colombo 1980). No data on nonradiological constituents in groundwater monitoring wells at West Valley have been reviewed for the present study.

The Beatty, Nevada, and Richland, Washington, LLW disposal site, both of which are currently operating, are located in arid regions; the water table is relatively deep at these sites (Clancy et al. 1981). No trench water or onsite groundwater sampling for organic or trace metal constituents has been performed at these sites. Samples from offsite groundwater wells adjacent to the Richland

LLW site did not exhibit elevated organics contamination (letter from D.A. Meyers, PNL, to Michael Brown, USEPA, 21 June 1984). No organic analyses are available for the Beatty site, although tritium was above background levels at two onsite wells. These sites were not included in the present preliminary sampling program due to the (estimated) low probability of nonradiological constituents migrating from the disposal units in groundwater.

C. Sampling Program

The preliminary sampling program (Appendix A) has the following specific objectives:

- Develop an order of magnitude assessment of the migration of hazardous nonradiological constituents from LLW disposal units
- Provide preliminary data to assess the need and scope for comprehensive sampling and other activities
- Provide insight on potential problems prior to comprehensive sampling
- Assist in optimizing sampling locations and analyses for future monitoring.

The first objective is paramount; these data will help provide a realistic perspective of the problem from which to develop an appropriate regulatory response.

The Sheffield, Illinois and Barnwell, South Carolina LLW disposal sites were chosen to provide representative characterization of LLW sites. Although both of these facilities were sited prior to promulgation of Part 61, and both have exhibited tritium migration, observed concentrations are below limits in 10 CFR Part 20. In this sense, these disposal facilities are performing within design specifications. However, migration of tritium has occurred and it is likely that some migration of nonradiological constituents from the LLW disposal units (if present) has occurred. This is supported by elevated organic carbon concentrations in trench water and groundwater at both sites. In addition, each site's hydrogeology is considered relatively well understood at this time and a large number of groundwater monitoring locations exist.

II. SHEFFIELD SAMPLING PROGRAM AND RESULTS

A. Background

The Sheffield low-level radioactive waste (LLW) disposal facility was selected for this sampling program for the following reasons: organics have previously been detected in groundwater near the site; tritium transport in groundwater is known to occur and is relatively well understood; and, an extensive groundwater monitoring system is in place at the site. The site is located in north central Illinois near the western boundary of Bureau County (Fig. 1). The facility received waste between 1967 and 1978; currently a closure plan is under development. Waste disposed at Sheffield included materials containing organic chemicals such as "tritiated oil" and "labeled organics" (MacKenzie et al. 1985). Tritium is migrating from the disposal units through groundwater and has resulted in levels of over 50 nCi/l in near-by offsite wells (Foster et al. 1984b). Figure 2 indicates site features, location of geologic section B-B', and locations of wells sampled for organic and other nonradiological hazardous constituents.

The hydrogeology of the site has been investigated by the USGS. Foster and Erickson (1980) and Foster and others (1984a) describe the hydrogeology of the site area. Foster and others (1984c) describe the hydrogeologic setting of the area immediately east of the site. Garklavs and Healy (1985) modeled flow east of the site and discuss tritium migration. These reports are sumarized by Goode (1985). Groundwater is under water table (unconfined) conditions in the glacial and recent alluvial materials at the site. These units overlie shale bedrock which is weathered in the upper portion. The water table is generally more than 30 ft below land surface and 5 ft below trench bottoms, except at trench 18 (NRC 1981). The geologic units which control groundwater flow are described below. Figure 3 is representative of the site stratigraphy (from Foster et al. 1984c).

Bedrock in the site area is a shale of the Carbondale Formation of the Desmoinesian Series. The topography of this weathered shale is similar, though not identical, to the land surface topography. This formation is believed to isolate the shallow groundwater system from deeper bedrock aquifers (Garklavs and Healy 1985). Coal seams in this unit have been mined locally. The Hulick Till lies unconformably on the bedrock and is composed of sand-silt-clay with some gravel layers. In the absence of gravel layers, the hydraulic conductivity of this member is relatively low (Foster et al. 1984a). This till does not overlie bedrock in all locations and is on occasion separated from bedrock by other members of the Glasford Formation, of which the Hulick is a member.

The Toulon Member of the Glasford Formation consists of sand, silty-sand, and sand and gravel, and is the most permeable hydrogeologic unit at the site (Garklavs and Healy 1985). Over much of the site, the bottom of the Toulon consists of a thin silt overlying the Hulick Till. In some areas sands of the Toulon rest directly on the till. On the northeast corner of the site, a very narrow shallow depression in the till is filled by a pebbly-sand unit of the Toulon Member (Fig. 4). Results of a natural gradient tracer test in the pebbly-sand unit east of the site indicate groundwater velocity of about 6.9 ft/day (2,500 ft/year) (Garklavs and Toler, 1985).

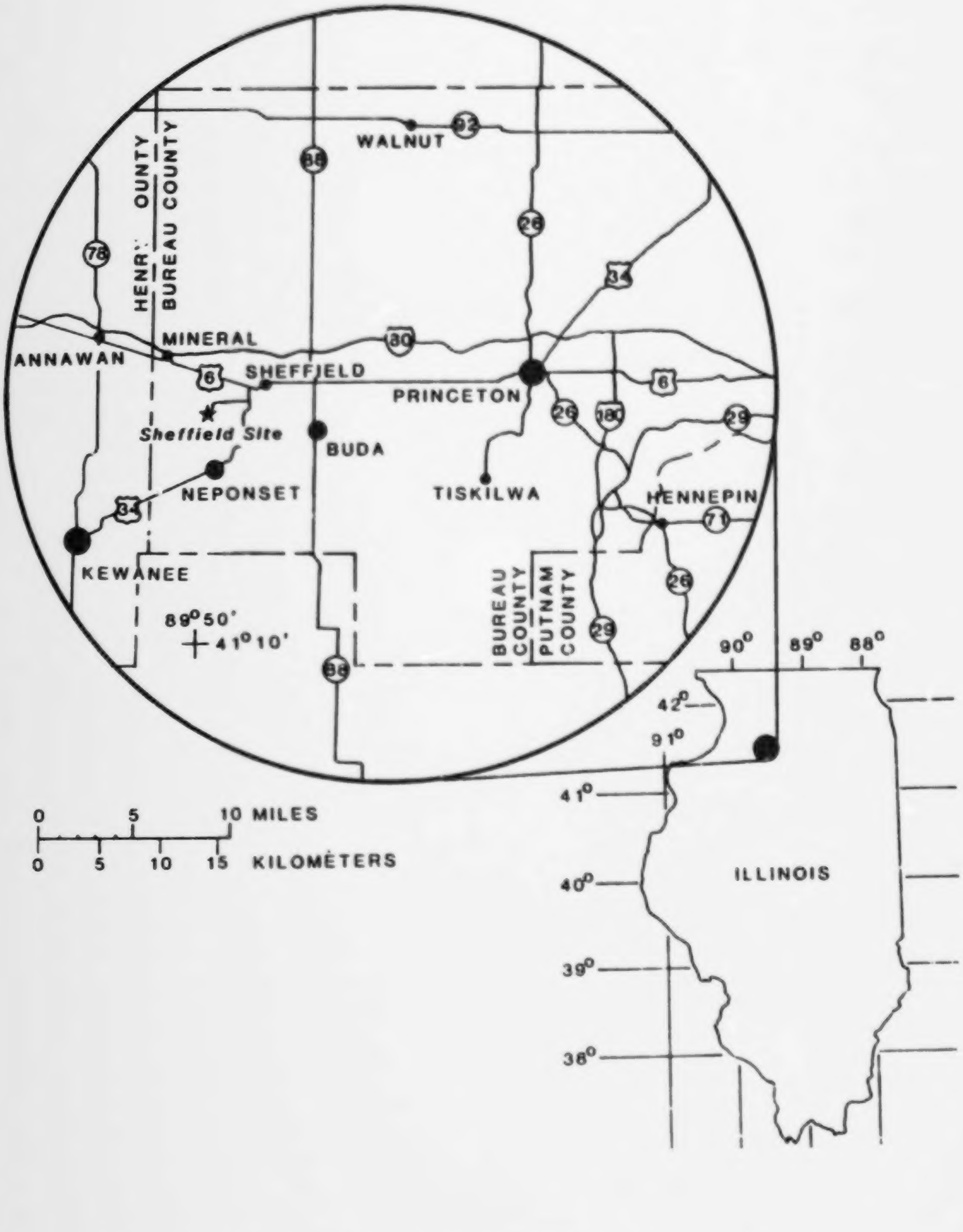
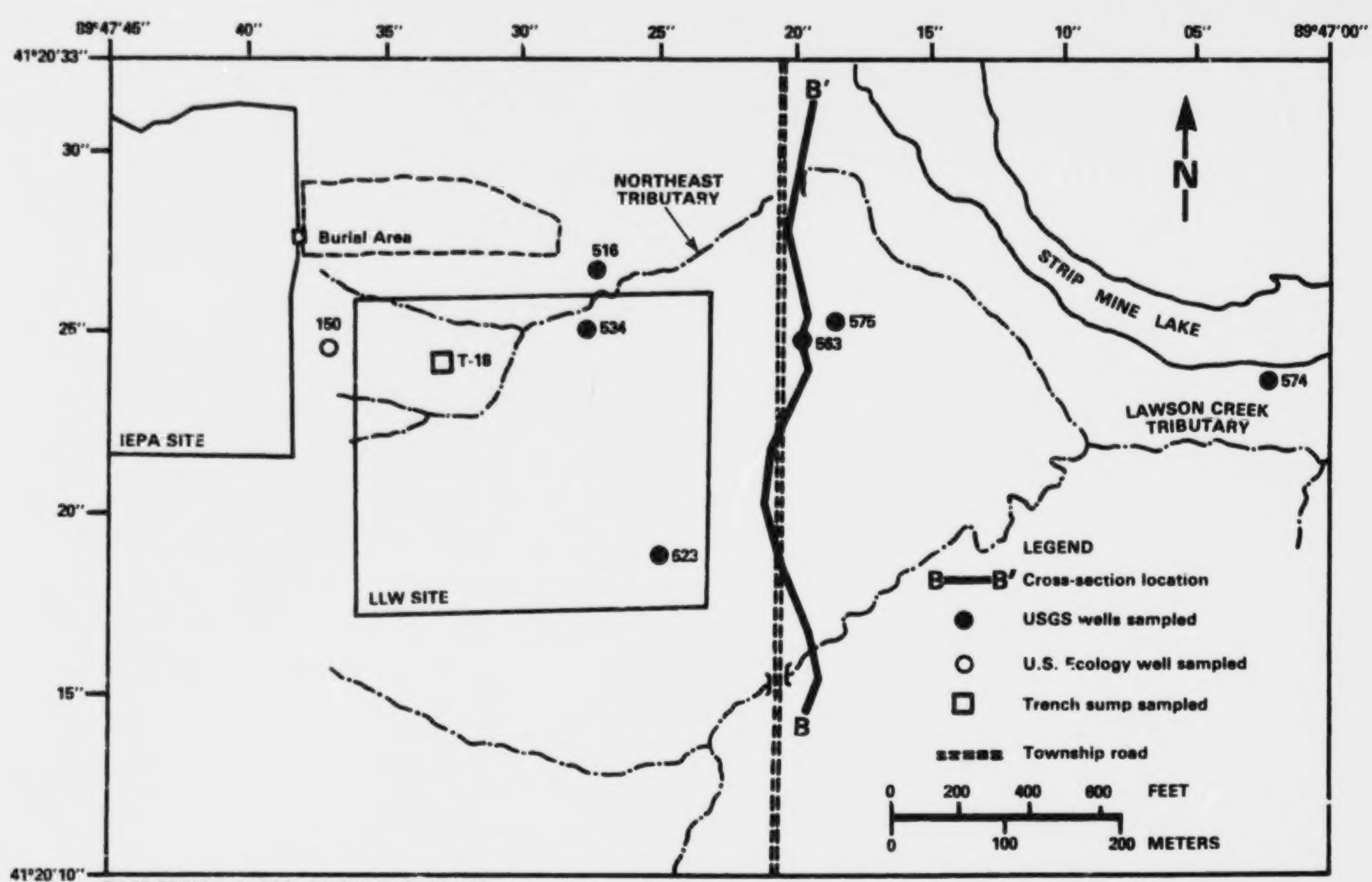

HENRY COUNTY
BUREAU COUNTY
WALNUT
92
88
26
78
34
MINERAL
80
ANNAWAN
6
SHEFFIELD
PRINCETON
6
Sheffield Site
BUDA
26
180
29
TISKILWA
NEPONSET
HENNEPIN
34
71
KEWANEE
BUREAU COUNTY
PUTNAM COUNTY
26
89°50'
41°10'
29
88
90°
89°
88°
42°
91°
41°
40°
39°
38°
ILLINOIS
0 5 10 MILES
0 5 10 15 KILOMETERS

Figure 1. Site Location of Sheffield LLW disposal facility (from Foster et al. 1984c)


89°47'45"
40"
35"
30"
25"
20"
15"
10"
05"
89°47'00"
41°20'33"
30"
25"
20"
15"
41°20'10"
N
NORTHEAST TRIBUTARY
Burial Area
516
534
150
T-18
IEPA SITE
LLW SITE
623
B'
B
575
563
STRIP MINE LAKE
574
LAWSON CREEK TRIBUTARY
LEGEND
B—B' Cross-section location
USGS wells sampled
U.S. Ecology well sampled
Trench sump sampled
Township road
0 200 400 600 FEET
0 100 200 METERS

BASE FROM U.S. GEOLOGICAL SURVEY, 1981

Figure 2. Sheffield site features, location of geologic section B-B', and sample locations

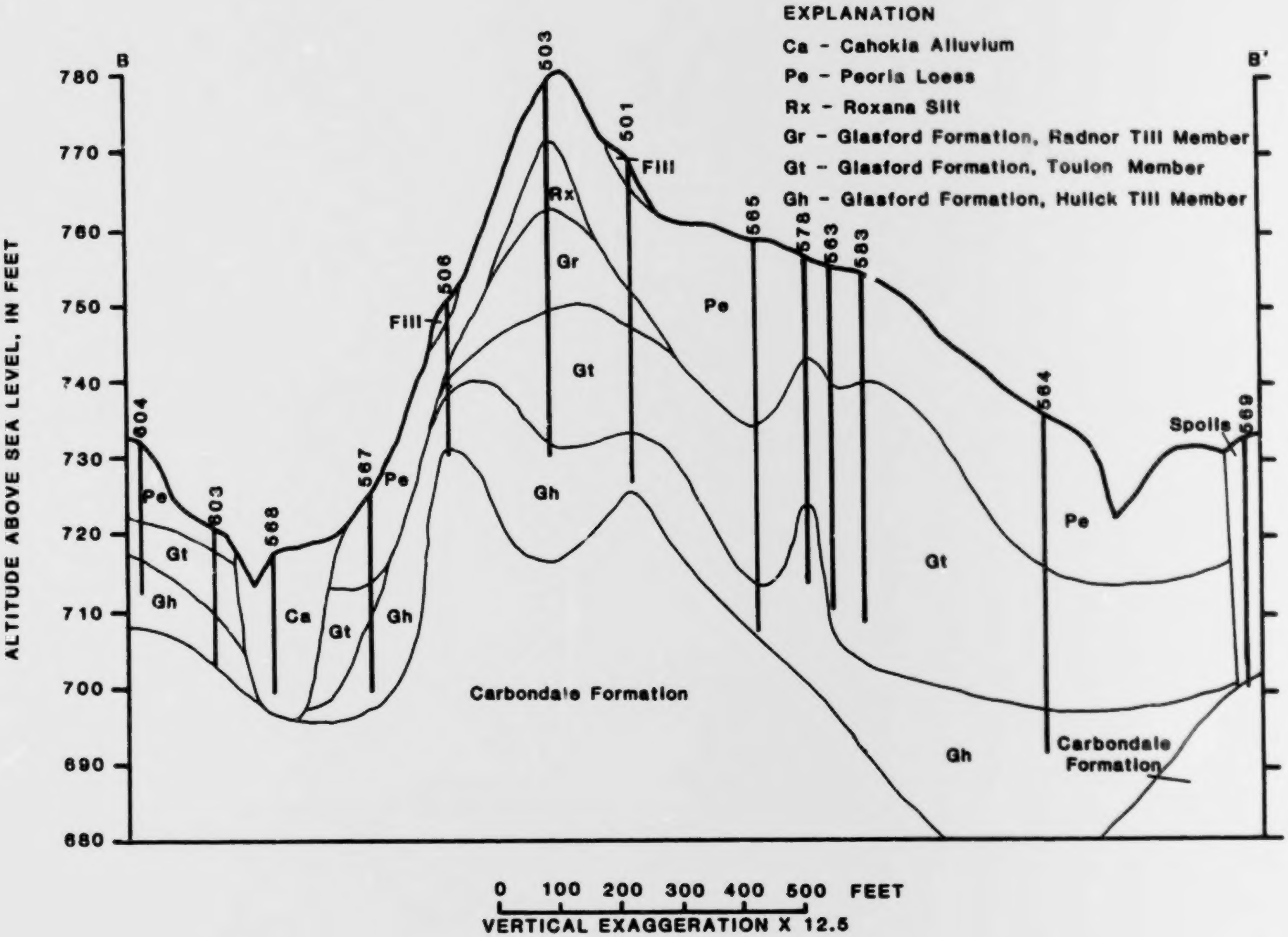
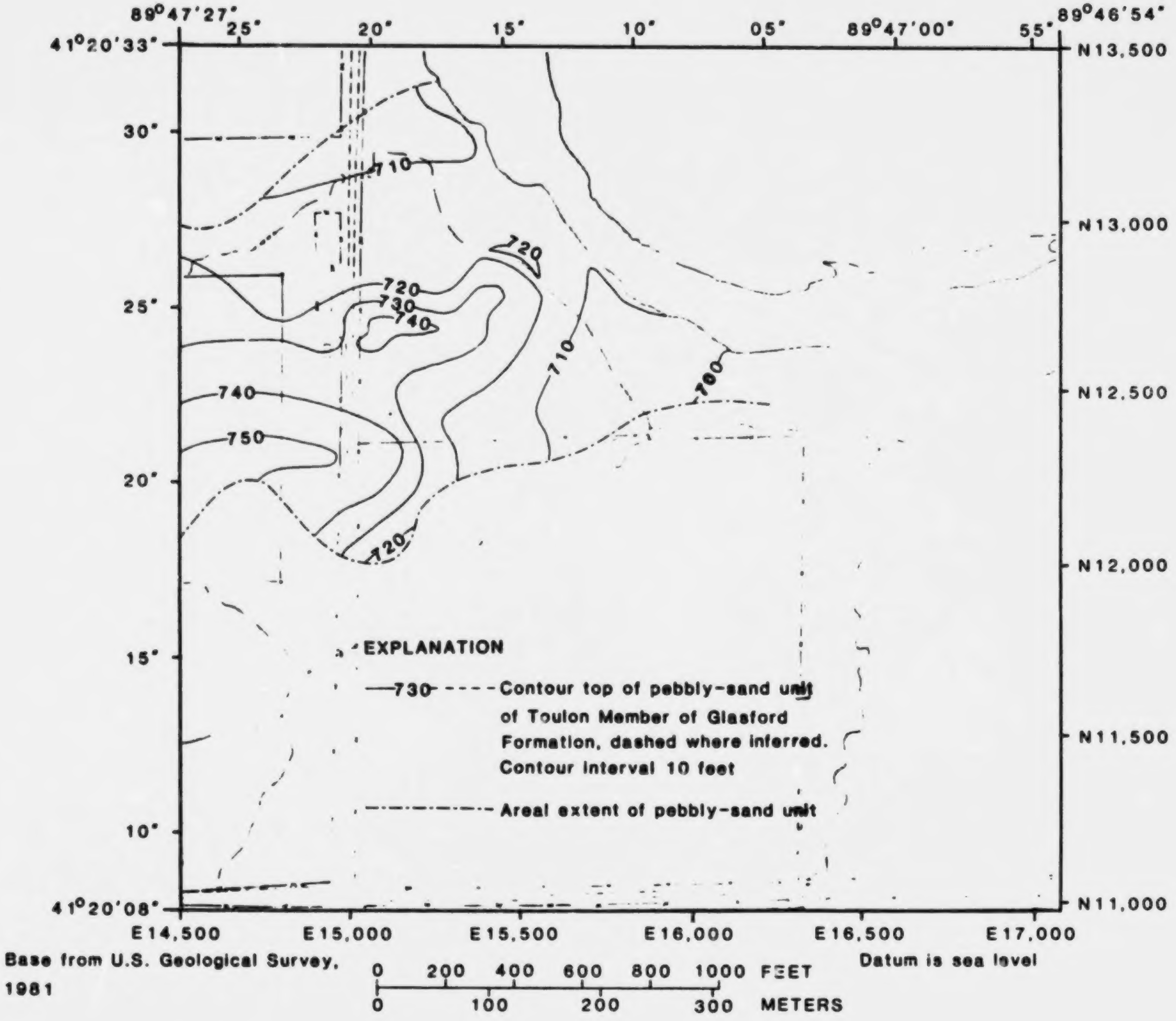

EXPLANATION
Ca - Cahokia Alluvium
Pe - Peoria Loess
Rx - Roxana Silt
Gr - Glasford Formation, Radnor Till Member
Gt - Glasford Formation, Toulon Member
Gh - Glasford Formation, Hulick Till Member
B
B'
ALTITUDE ABOVE SEA LEVEL, IN FEET
780
770
760
750
740
730
720
710
700
690
680
604
603
568
567
506
503
501
565
578
563
583
564
569
Fill
Fill
Spoils
Pe
Gt
Gh
Ca
Rx
Gr
Carbondale Formation
Carbondale Formation
0 100 200 300 400 500 FEET
VERTICAL EXAGGERATION X 12.5

Figure 3. Geologic section B-B' showing representative stratigraphy for Sheffield site (from Foster et al. 1984c)


89°47'27"
25"
20"
15"
10"
05"
89°47'00"
55"
89°46'54"
41°20'33"
30"
25"
20"
15"
10"
41°20'08"
N13,500
N13,000
N12,500
N12,000
N11,500
N11,000
E14,500
E15,000
E15,500
E16,000
E16,500
E17,000
710
720
730
740
750
760
EXPLANATION
730 Contour top of pebbly-sand unit of Toulon Member of Glasford Formation, dashed where inferred. Contour interval 10 feet
Areal extent of pebbly-sand unit
0 200 400 600 800 1000 FEET
0 100 200 300 METERS

Base from U.S. Geological Survey, 1981

Datum is sea level

Figure 4. Areal extent and thickness of pebbly-sand unit of Toulon Member of Glasford Formation (from Foster et al. 1984c)

The Radnor Till Member of the Glasford Formation occurs near the strip mine lake and the southern portion of the site. This till consists of clayey silt interbedded with coarse materials. The Peoria Loess, composed of silt and clayey-silt, covers the entire site outside of eroded stream channels. The LLW disposal trenches are constructed in an on top of the loess unit. The Cahokia Alluvium occurs beneath a tributary to Lawson Creek to the south of the site. This recent alluvium is clayey silty-sand of high permeability and acts as a groundwater drain for the southeast corner of the site (Garklavs and Healy 1985).

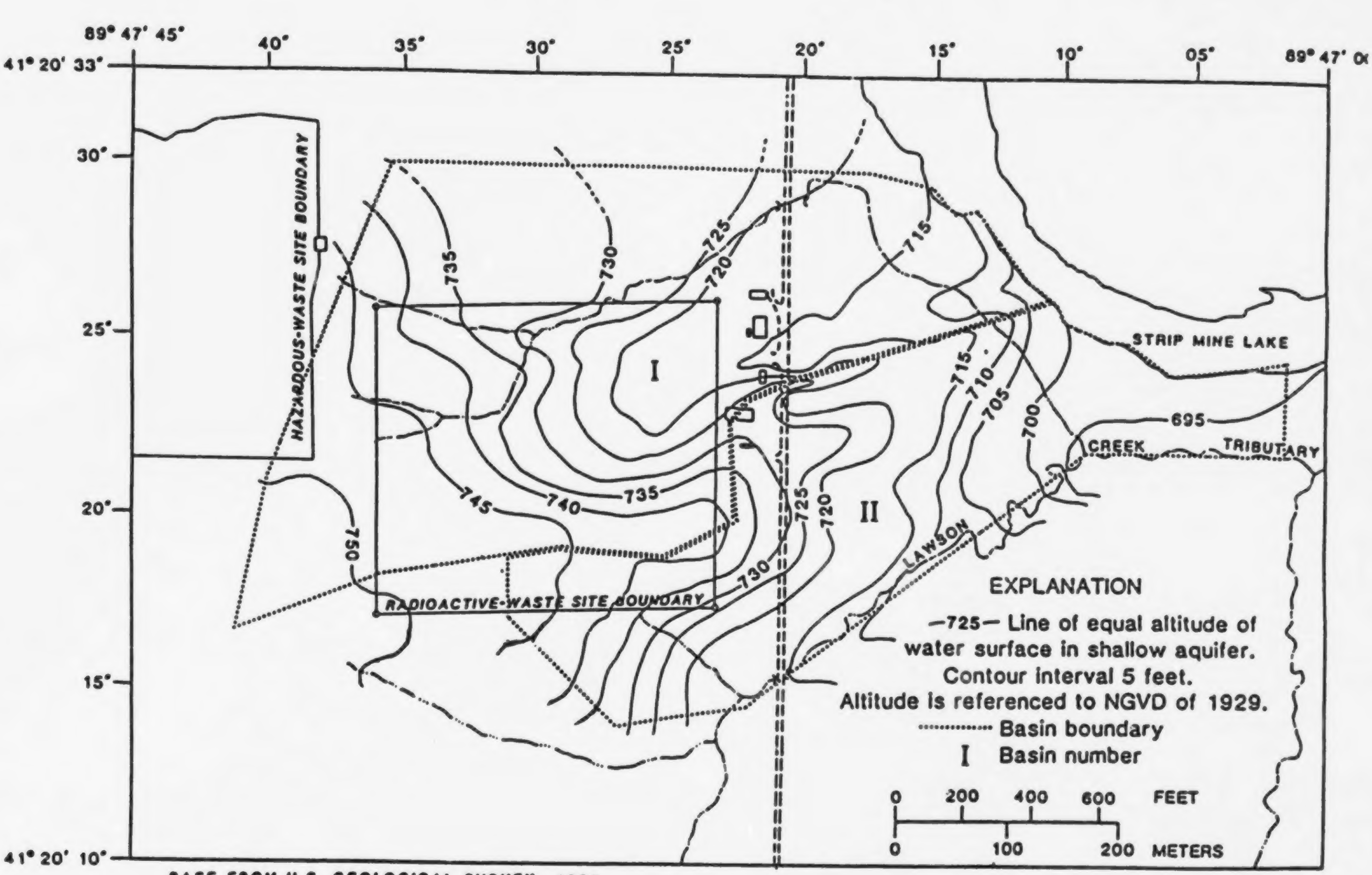
Of the average annual precipitation of 36 inches, an average of 1 to 4 inches is estimated to recharge local groundwater (Garklavs and Healy 1985). Recharge occurs primarily in the early spring when precipitation is high and plant transpiration and surface evaporation are low. In addition, spring snowmelt may contribute a significant portion of annual recharge, depending on climatic conditions.

Because most groundwater beneath the site comes from local recharge, there is very little groundwater inflow to the site area. This is indicated by the water table contour map developed by the USGS (Garklavs and Healy 1985) which also shows a groundwater divide crossing the site near trench 11 (Fig. 5). About 70 percent of groundwater discharge from the site occurs through the pebbly sand unit of the Toulon Member.

Tritium has migrated from the disposal units at Sheffield. Wells in the pebbly sand unit draining the site, particularly wells USGS-563 and USGS-575, and well USGS-523 next to Trench 11, exhibit the highest tritium concentrations. The plume in the pebbly-sand unit is confined to a width of 30-50 ft which is only slightly wider than the unit itself (Garklavs and Toler 1985).

Sampling and analysis for organic constituents have previously been performed by Brookhaven National Laboratory, the U.S. Geological Survey (USGS), Illinois Department of Nuclear Safety (IDNS) and Illinois Environmental Protection Agency (IEPA) (see Appendix D). These analyses indicated several organic constituents in groundwater in the site vicinity. However, all of the wells sampled are located such that they could be affected by disposal of chemical waste at either the adjacent IEPA licensed hazardous waste facility or at the unlicensed burial ground north of the LLW site (see Fig. 2). Organics detected include trichloroethylene, trichloroethane, tetrachloroethylene, dichloroethane, and chloroform. In well USGS-563, tetrachloroethylene was measured in the highest concentration of 120 μg/l. Several locations were also sampled for indicator parameters. Weiss and Colombo (1980) reported "organic carbon" concentrations of 50 mg/l and 40 mg/l for the Trench 18 sump and the USGS-523 respectively. The facility operator, U.S. Ecology, Inc. (USE), also analyzed groundwater for a few organics and reported that no toluene or xylene was found above their detection limit of 10 μg/l in 9 onsite and offsite groundwater wells (letter from W. K. Waller to J. Shaffner, November 13, 1984, WM Docket 27-39). These results are discussed in more detail below.

USGS analyzed samples taken on July 19, 1984 from trench 18 and well 563 for organics (see Appendix B). Well 563 indicated elevated levels of tetrachloroethylene (62 μg/l), trichloroethylene, dichloroethane, and chloroform. Toluene was below the detection limit. The trench 18 sump indicated elevated levels of only dichloroethane. IEPA sampled well 563 in November, 1983. Elevated


89° 47' 45"
40"
35"
30"
25"
20"
15"
10"
05"
89° 47' 00"
41° 20' 33"
30"
25"
20"
15"
41° 20' 10"
HAZARDOUS-WASTE SITE BOUNDARY
RADIOACTIVE-WASTE SITE BOUNDARY
I
II
750
745
740
735
730
725
720
715
710
705
700
695
STRIP MINE LAKE
CREEK
TRIBUTARY
LAWSON
EXPLANATION
—725— Line of equal altitude of water surface in shallow aquifer. Contour interval 5 feet. Altitude is referenced to NGVD of 1929.
Basin boundary
I Basin number
0 200 400 600 FEET
0 100 200 METERS

BASE FROM U.S. GEOLOGICAL SURVEY, 1981

Figure 5. Contour map of June 1982 water table elevation, Sheffield site (from Garklavs and Healy 1985)

levels of tetrachloroethylene (120 μg/l), trichloroethane, trichloroethylene, dichloroethane, and chloroform were detected. Toulene and xylene were not detected.

B. Sampling and Analysis Procedures

January Sampling -

Water samples were collected from four monitoring wells (USGS-523, 563, 574, and 575) and one trench sump (T-18) on January 14-15, 1985 (see Fig. 2; Appendix A). Figures in Appendix D show the construction of the 4 USGS wells with adjacent stratigraphy.

Sampling was performed by Oak Ridge National Laboratory (ORNL) staff (R. H. Ketelle and J.T. Kitchings) with the assistance of USE and IDNS personnel. USE and IDNS staff took split samples at all wells except USGS-523. Well 523, which is screened in till, did not recover quickly enough after purging to obtain a full sample. Sufficient water was recovered for only organics analyses; no split samples were taken for this well. The other three wells, USGS-563, USGS-574, and USGS-575, were bailed for 2-3 well volumes prior to sampling. Trench sump 18, which recovered rapidly, was bailed for 2 well volumes. Specific conductance and pH were measured during bailing at wells 563 and 575 and were stable prior to sampling. Location and weather conditions precluded this activity at Trench 18 and well 574. Sample containers, with preservatives as needed, were filled directly from the dedicated bailers. Metals samples were filtered using 0.45 micron micropore filter immediately after sampling. The details of the January sampling procedures are documented by Ketelle and others (1985; Appendix B).

September Sampling -

Water samples were collected from seven wells (USE-150, USGS-516, 523, 534, 563, 574, and 575) on September 18, 1985 (Fig. 2; Appendix C). These samples were taken because of analytical difficulties and uncertainties associated with the organic concentrations of the January samples. These problems are discussed below and in Appendix C in detail.

Sampling was performed by ORNL staff (R. Ketelle, K. Owenby, and K. Edwards) with the assistance of USE personnel. USE took split samples at all wells. General sampling procedures were as described above. To reduce loss of volatile organic samples, septum vials were inserted in a teflon bailer which was lowered down the well. This bailer reduced air bubbling and mixing of samples. Temperature, pH, specific conductance, and dissolved oxygen were measured during bailing at all wells. Redox potential was measured immediately after bailing. The details of the September sampling procedures are documented by Ketelle (1986; Appendix C).

All analyses were performed at ORNL. EPA's proposed Method 8600 (HAP) was utilized for the determination of organic constituent concentrations (EPA 1984). The HAP prescribes several screening tests to determine what individual analyses should be performed. All other analyses (major ions, hazardous metals) were performed using EPA procedures (Ketelle et al. 1985). Two sets of field split samples and various spiked samples were also analyzed for Quality Assurance/ Quality Control. Samples collected in September were also analyzed using EPA

Methods 624 and 625 for volatile and semi-volatile organics. These analyses were done separately from the HAP to ensure accurate determination of individual organic chemical concentrations.

C. Results and Discussion

Ketelle and others (1985) present the detailed results of analysis of samples collected in January 1985. Results from September 1985 sampling are presented by Ketelle (1986). These reports are reprinted as Appendices B and C of this document. Table 1 shows the concentrations of metals and anions in groundwater wells and the trench sump in January 1985. Cation concentrations are shown in Table 2. Table 3 shows radionuclide and TOC (total organic carbon) and TOX (total organic halogens) concentrations. Table 4 shows the tentative identification of volatile and semi-volatile organics, and concentrations of organic indicators TOX (total organic halogens), TOC (total organic carbon), and total volatiles for samples collected in January. Metals, cations, anions, tritum, TOC, and TOX for samples collected in September 1985 are shown in Table 5. Organic volatile concentrations in samples collected in September are shown in Table 6.

An upgradient background well was not sampled because most groundwater flow originates on site as recharge (Garklavs and Healy 1985). However, well 574 is not in the pathway of groundwater leaving the site and this well is considered to represent the general quality of groundwater unaffected by waste disposal activities. Other human activities which may affect (or have affected) water quality at well 574 include strip mining and agriculture.

In general, onsite sampling locations and wells in the pebbly-sand unit offsite exhibit elevated levels of several constituents. Sulfate, bicarbonate, magnesium, manganese, and TOC, are all higher at Trench 18, and wells 523, 563, and 575 than at wells 574 (considered to represent background), 150, 516, and 534.

Of the two offsite wells in the tritium plume area, 563, which is closer to the site, shows higher levels of organics than 575. Tritium levels at these two wells are very similar (Tables 3 and 5; cf. Foster et al. 1984b). The fact that organics are higher at 563 suggests that the site soils may retard organics relative to tritium, which moves at the rate of the groundwater. Other processes, such as biodegradation and spatial variability could also cause these variable concentrations.

Well 523, which is adjacent to Trench 11 onsite, shows the highest concentrations of organics of the sampled wells. The sands of the Toulon are not saturated in this area and groundwater flow rates are very low (Garklavs and Healy 1985). The water table contour map (see Fig. 5) indicates a groundwater divide running across the site just north of well 523. Thus, groundwater flowing from the adjacent hazardous chemical waste disposal facility would not flow into well 523. However, groundwater from that facility may be flowing into Trench 18, and wells 563 and 575. The Trench 18 sump shows the highest concentrations of TOC of all sampling locations.

Preliminary analysis of samples collected in January identified several volatile compounds including trichloromethane, trichloroethane, tetrachloroethylene, and trichloroethylene, and several semi-volatile organics. Concentrations of these

Table 1 Metals and anions concentrations in Sheffield groundwater samples, 14-15 January 1985 (from Ketelle et al. 1985)

Parameter	Units of Measurement	Well 574	Well 574-1[a]	Well 575	Well 563	Trench 18	Trench 18-1[a]
			Metals measured by atomic absorption				
Ag	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
As	"	0.002	0.052[b]	0.005	<0.001	0.003	0.042[b]
Ba	"	0.30	0.22	0.52	0.22	0.33	0.37
Cd	"	0.0002	0.0005[b]	0.0002	0.0004	0.0007	0.0015[b]
Cr	"	0.002	0.019[b]	<0.002	<0.002	0.003	0.009[b]
Cu	"	0.011	0.01	0.004	0.005	0.020	0.01
Pb	"	<0.001	0.002	<0.001	<0.001	0.002	0.002
Ni	"	<0.005	<0.005	<0.005	0.011	0.028	0.046[b]
Se	"	<0.003	0.007[b]	<0.003	<0.003	<0.003	0.008[b]
Sb	"	<0.004	<0.004	<0.004	<0.004	0.007	0.008
Hg	"	<0.00005	0.0004[b]	<0.00005	<0.00005	<0.00005	0.0014[b]
			Anions				
Br	"	<5	<5	<5	<5	<5	<5
Cl	"	13	4	4	19	32	23
F	"	<1	<1	<1	<1	<1	<1
CO_3	"	0.0	0.0	0.0	0.0	0.0	0.0
HCO_3	"	436	440	563	562	1173	1161
NO_2	"	0.3	0.4	0.3	0.3	1.2	0.9
NO_3	"	<5	<5	<5	<5	<5	<5
SO_4	"	84	89	295	171	380	390
Cyanide	"	<0.0014	<0.002	<0.0014	<0.0014	0.0016	0.0032
Sulfide	"	<0.1	<0.1	<0.1	<0.1	c	<0.1

Table 2 Cations concentrations in Sheffield groundwater samples, 14-15 January 1985 (from Ketelle et al. 1985)

Parameter	Units of Measurement	Well 574	Well 574-1[a]	Well 575	Well 563	Trench 18	Trench 18-1[a]
		Cations measured by inductive coupled plasma					
Al	mg/l	<0.2	<0.2	<0.2	<0.2	0.44	0.34
B	"	0.59	0.74	0.32	2.1	27	27
Be	"	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ca	"	89	88	160	170	240	240
Co	"	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fe	"	0.44	0.4	0.65	0.22	0.28	0.22
Ga	"	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hf	"	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
K	"	2.8	2.9	0.8	0.9	120	120
Li	"	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mg	"	47	46	70	69	120	120
Mn	"	0.17	0.17	1.9	1.1	1.1	1.1
Mo	"	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Na	"	53	52	18	17	190	200
P	"	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Si	"	9.9	9.7	16	14	11	11
Sr	"	0.7	0.68	0.18	0.19	0.89	0.89
Ti	"	<0.02	<0.02	<0.02	<0.02	0.025	0.022
V	"	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Zn	"	<0.02	<0.02	<0.02	0.073	0.17	0.18
Zr	"	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06

[a] Samples 574-1 and Trench 18-1 are duplicated sample splits obtained for quality assurance purposes.

[b] Value reported from a spiked sample with incomplete spike recovery - reported value is a maximum concentration.

[c] Sample was accidentally lost during preparations for shipping.

Table 3 Radionuclide, TOC, and TOX concentrations in Sheffield groundwater samples, 14-15 January 1985 (from Ketelle et al. 1985)

Parameter	Units of Measurement	Well 574	Well 574-1[a]	Well 575	Well 563	Trench 18	Trench 18-1[a]
Gross alpha	pCi/l	19±108	2.7±111	81±135	81±135	81±135	39±122
Gross beta	"	54±125	5.4±119	<108	13.5±127	1.3E3±2.4E2	1.2E3±2.4E2
Tritium	"	<810	<810	1.5E5±2.7E3	1.7E5±2.7E3	4.3E5±2.7E4	4.3E5±2.7E4

Parameter	Units of Measurement	Well 574	Well 574-1[a]	Well 575	Well 563	Trench 18	Trench 18-1[a]	Well 523
TOC	mg/l	2.8	1.9	2.9	10	48	43	40
TOX	µg/l	3,950	b	3,600	140	11,000	2,250	5,450

[a] Samples 574-1 and Trench 18-a are duplicate sample splits obtained in the field for Quality Assurance purposes.

[b] Sample bottle broke after receipt at lab while warming.

Table 4 Tentative identification of volatile organics in Sheffield groundwater samples, 14-15 January 1985 (from Ketelle et al. 1985)

Component	Sample Origin				
	Trench	Well No.			
	18	523	563	574	575
Trichloromethane	15	<1	<1	nd	nd
Trichloroethane	1	1	<1	nd	nd
Benzene ?	<1	nd	nd	nd	nd
Cyclohexene	>15	>10	>5	nd	X
Trichloroethylene ?	1	<1	<1	nd	nd
Dioxane	>15	11	5	nd	3
Perchloroethylene	11	4	1	nd	nd
Cyclohexene Oxide	1	<1	<<1	nd	nd
Cyclohexenol	<1	<<1	nd	nd	nd
Unknown - Glycol with Nitrogen function (M.W. 91)?[b]	X	X	X	nd	nd
Methyl cyclohexene ?	X	X	nd	nd	nd
Unknown - chlorinated Oxygenated hydrocarbon (M.W. 249)?[b]	X	X	nd	nd	X

[a] Quantities listed in Table have units of μg/l. Entries marked with an X indicate that the compound was detected but not quantitated; nd indicates not detected. Quantities were estimated from chromatographic areas of the various gas chromatograms generated by the application of the Appendix VIII methods (8010, 8015, 8030, and 8620). Identifications are based on a GC/MS study of the combined acid and base-neutral extracts of the water with highest content (Trench 18).

[b] These compounds cannot be tentatively identified from their mass spectra; however, based on the intensity of their peaks in the chromatogram, both are major organic constituents. Therefore, they are listed along with their apparent molecular weight.

Table 5 Metals, cations, anions, tritium, TOC, and TOX concentrations in Sheffield groundwater samples, 18 Septemter 1985 (from Ketelle 1986)

Table 1

RESULTS OF WATER ANALYSES[a]

SHEFFIELD, ILLINOIS LLWD SITE

Parameter	Well 523	Well 563	Well 574	Well 575	Well 150	Well 534	Well 516
Metals							
Ag	$<0.0002^b$	<0.05	$<0.0002^b$	<0.05	$<0.0002^b$	$<0.0002^b$	$<0.0002^b$
Al	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
As	$<0.003^c$	<0.10	0.002^c	<0.10	0.017^c	0.002^c	$<0.002^b$
B	5.9	2.1	0.44	0.45	<0.08	0.12	<0.08
Ba	$<0.1^b$	0.12	$<0.1^b$	0.20	0.37^b	$<0.1^b$	$<0.1^b$
Be	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Ca	170	190	110	190	120	52	110
Cd	$<0.0001^b$	<0.005	0.0001^b	<0.005	$<0.0003^b$	0.0001^b	0.0001^b
Co	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cr	$<0.009^b$	0.04	0.004^b	<0.04	0.006^b	0.003^b	0.006^b
Cu	<0.02	<0.02	0.005^b	<0.02	0.006^b	0.007^b	0.007^b
Fe	3.4	0.44	1.1	5.2	0.17	0.40	0.55
Ga	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Hg	<0.00005	d	<0.00005	d	<0.00005	<0.00005	<0.00005
K	3.3	0.8	3.0	1.0	1.6	1.6	0.9
Li	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Mg	140	55	39	57	37	25	40
Mn	0.39	1.9	0.14	1.7	0.46	0.095	0.15
Mo	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Na	41	13	37	14	8.9	9.4	10
Ni	$<0.01^b$	<0.06	$<0.01^b$	<0.06	$<0.01^b$	$<0.01^b$	$<0.01^b$
P	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Pb	$<0.007^b$	<0.20	0.003^b	<0.20	0.006^b	0.004^b	0.004^b
Sb	$<0.005^b$	<0.20	$<0.005^b$	<0.20	$<0.005^b$	<0.005	$<0.005^b$
Se	$<0.005^c$	<0.20	$<0.005^c$	<0.20	<0.005	$<0.005^c$	$<0.005^c$
Si	8.1	10	8.2	13	8.0	2.2	10
Sr	0.18	0.056	0.60	0.048	0.23	0.088	0.046
Ti	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
V	0.071	0.071	0.062	0.065	0.061	0.036	0.063
Zn	0.03	0.032	<0.02	0.038	0.034	<0.02	<0.02
Zr	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Anions							
Br	<5	<5	<5	<5	<5	<5	<5
Cl	23	19	4	12	1	4	17
CO_3	0	0	0	0	0	0	0
HCO_3 (mg/L)	1134	572	438	548	456	226	386
F	<1	<1	<1	<1	<1	<1	<1
NO_2	<5	<5	<5	<5	<5	<5	<5
NO_3	<5	5	<5	<5	<5	<5	<5
PO_4	<5	<5	<5	<5	<5	<5	<5
SO_4	120	150	69	180	16	46	53
Other							
TOC	33	29	5.3	7.3	4.6	4.1	3.6
TOX^e µg/L	6.0×10^5	1.6×10^5	1.1×10^5	1.9×10^5	2.3×10^5	1.6×10^5	9.3×10^4
Tritium pCi/L	$4.32 \times 10^5 \pm 2.7 \times 10^4$	$1.92 \times 10^5 \pm 2.7 \times 10^3$	$<8.1 \times 10^2$	$1.78 \times 10^5 \pm 2.7 \times 10^3$	$<8.1 \times 10^2$	$<8.1 \times 10^2$	$<8.1 \times 10^2$

[a] All concentrations are µg/ml unless otherwise indicated.
[b] Metals analyzed by graphite furnace atomic absorption. Other metals were analyzed by ICP.
[c] Arsenic and selenium were analyzed by the metal hydride method.
[d] Mercury analyses were not performed on these samples.
[e] TOX values are unrealistically high.

Table 6 Volatile organic concentrations in Sheffield groundwater samples, 18 September 1985 (from Ketelle 1986)[a]

Compound	NPDES ID	Well No. 523	563	574[b]	575	150	534	516
Trans 1,3-dichloropropene	3				<1			
Benzene	4	3			<1		<1	85
Chlorobenzene	7	<1						<1
1,1,2-trichloroethane	14	<1			<1		<1	
1,1,2,2-tetrachloroethane	15	<1						
1,2-dichloropropane	32	4						4
Cis 1,3-dichloropropene	33	<1						
Bromoform	47							
Bromodichloromethane	48							
Dibromochloromethane	51							
Tetrachloroethylene	85	14			110			>1000[c]
Toluene	86	<1			<1		<1	<1
Trichloroethylene	87	3			10		<1	22
Carbon Tetrachloride	6	<1				6		
1,2-dichloroethane	10	2	21		9			2
1,1,1-trichloroethane	11	>>1000[c]	>1000[c]	6	>1000[c]	6		6
1,1-dichloroethane	13	320	89		117			<1
Chloroform	23	209	10		2	<1		175
1,1-dichloroethylene	29	6			5			
1,2-dichloroethylene	30		2		1	<1	<1	2
Methylene Chloride	44	7	1	1		5		12

[a] All concentrations are μg/l; A "less than" entry indicates that the mass spectrometer may have detected the compound at a level too low to be quantitated; No entry indicates that the compound was not detected by the mass detector.

[b] Background well.

[c] These values are very high and exceed the dynamic range of the detector. Estimated 1,1,1-trichloroethane concentrations are 12, 3.2, and 2.5 mg/l for wells 523, 563, and 575, respectively. The estimated tetrachloroethylene concentration in well 516 is 1.4 mg/l.

organics were estimated from a GC/MS run of a extract from the Trench 18 sample. Subsequently, the more accurate EPA Method 1625 was carried out to identify specific organics concentrations. However, this method was applied to improperly collected and stored samples. As a result, very few organic chemicals were detected by this method and volatile organic concentrations were very low (Ketelle et al. 1985; Appendix B). These factors caused NRC and ORNL staff to conduct additional sampling in September 1985 to more accurately quantify concentrations of individual volatile and semi-volatile organic constituents.

Samples collected in September 1985 exhibit significant concentrations of volatile organic compounds (Table 6). Concentrations of several organics exceed EPA's proposed drinking water standrds (Appendix F). Wells 523, 563, and 575 contain 1,1,1-trichloroethane in estimated concentrations of 12, 3.2, and 2.5 mg/l, respectively. The tetrachloroethylene concentration in well 516 is over 1 mg/l. High concentrations of chloroform, 1,1-dichloroethane, and benzene are present. Trichloroethylene is detected in four wells with the highest concentration of 22 µg/l in well 516. The sample from well 574, the background well, contains 6 µg/l 1,1,1-trichloroethane and 1 µg/l methylene chloride. Five volatile organics are identified in well USE-150 at low concentrations (less than 6 µg/l). Five volatile organics are present at less than detection limits (1 µg/l) in well 534. Toluene is present at less than detection limit (1 µg/l) in wells 523, 575, 534, and 516. Xylene is not detected in any sample. Hydrocarbons associated with petroleum products are detected in all wells sampled (Ketelle 1986).

Organic chemical concentrations are positively correlated with tritium measurements for the Sheffield site. The levels of TOC and 1,1,1-trichloroethane increase with increasing tritium levels for the wells sampled (Figs. 6 and 7). The tritium levels measured in the present sampling effort are consistent with previous data (Foster et al. 1984a; IDNS files), indicating that the organic constituent levels should also be fairly representative of normal conditions. The correlation between organic concentrations and tritium supports the hypothesis that at least a portion of the organic chemicals are associated with the tritium source, namely the LLW disposal units. It appears that organics are migrating from the LLW trenches along with tritium. Where tritium is not correlated with the organics concentration, tetrachloroethylene at well 516 for example, the organics are primarily from some source other than the LLW trenches. The observed correlation between organic and tritium from the LLW indicates that tritium may be an appropriate parameter for detection monitoring to screen for organic contamination at this site. These hypotheses are, of course, based on a very limited sampling effort and should be considered preliminary.

Groundwater at Sheffield exhibits elevated levels of tritium at several onsite wells and in two offsite areas: the first is in a subsurface pebbly-sand channel extending from the site eastward to the strip-mine lake; the second is in an isolated location to the site's southeast (Fig. 8). Four of the locations from the present sampling effort which indicate elevated organics concentrations are within the area of identified tritium contamination. In addition, it is noted that well 575, which is further from the site than 563, contains less organic constituents than 563 even though its tritium level is essentially the same as 563. Tritium concentrations in the pebbly-sand plume area (wells 563 and 575) vary significantly over very short distances and it is possible that higher concentrations than those measured at 563 occur near 563. The difference in organic concentrations may indicate that tritium moves faster in groundwater than organic constituents at this site, and that tritium could serve as an early warning or screening parameter for organic contamination. The extent to which

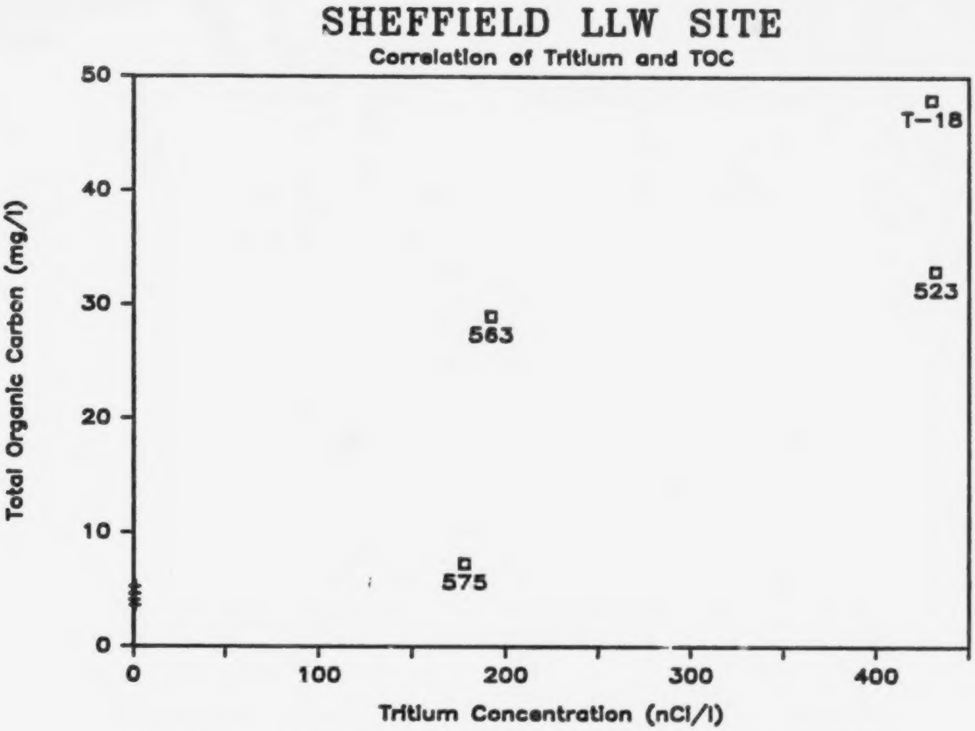


Figure 6. Plot of total organic carbon versus tritium for Sheffield samples

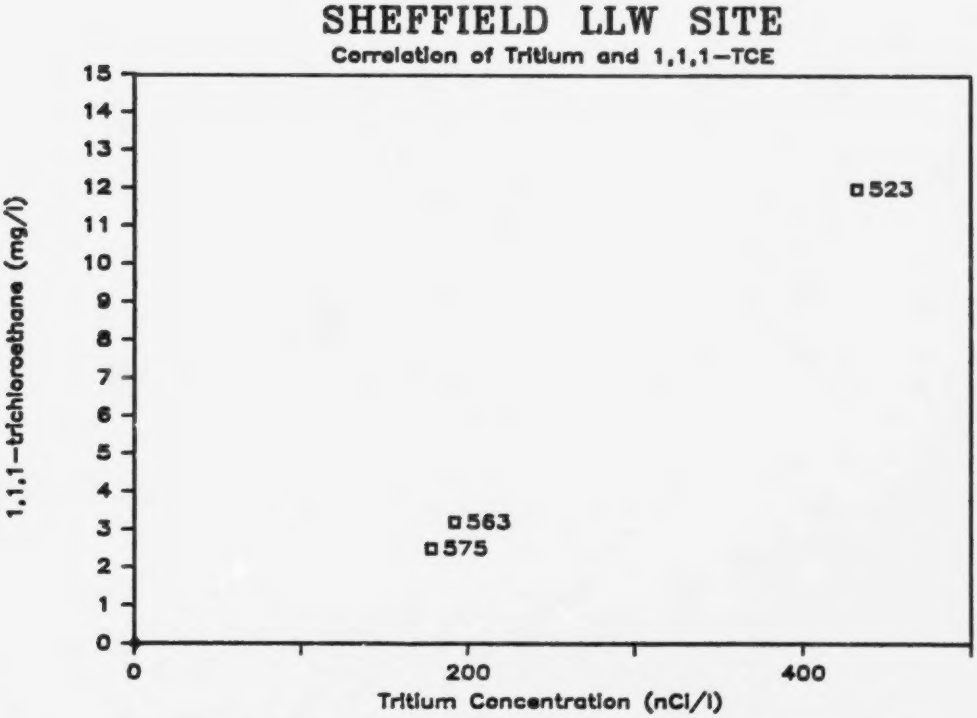


Figure 7. Plot of 1,1,1-trichloroethane versus tritium for Sheffield samples

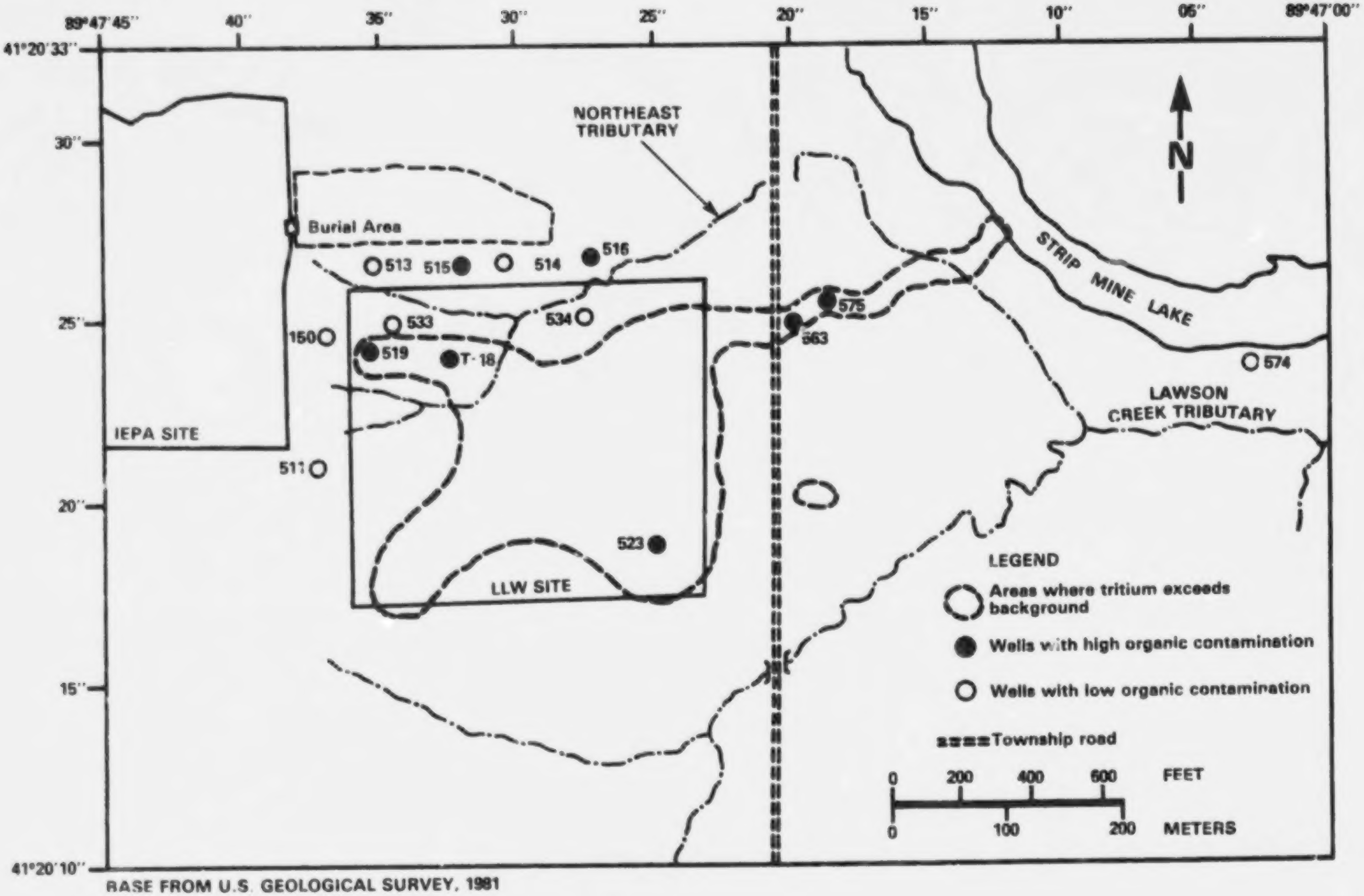

89°47'45"
40"
35"
30"
25"
20"
15"
10"
05"
89°47'00"
41°20'33"
30"
25"
20"
15"
41°20'10"
NORTHEAST TRIBUTARY
Burial Area
513
515
514
516
533
534
150
519
T-18
575
563
STRIP MINE LAKE
574
LAWSON CREEK TRIBUTARY
IEPA SITE
511
523
LLW SITE
N
LEGEND
Areas where tritium exceeds background
Wells with high organic contamination
Wells with low organic contamination
Township road
0
200
400
600
FEET
0
100
200
METERS
BASE FROM U.S. GEOLOGICAL SURVEY, 1981

Figure 8. Map showing areas of Sheffield site where tritium has been detected above background concentrations (after Garklavs and Healy 1985) and relative concentrations of organics in wells

this relationship applies would be clarified by further sampling both within and outside the tritium contaminated areas.

The Sheffield LLW site is located adjacent to an IEPA licensed hazardous waste disposal facility (chem site) and to a previously utilized unlicensed chemical waste burial area which could cause organic contamination at the LLW site. Examination of concentrations in samples from wells USE-150, USGS-516, and 534 indicates, along with previous results, that the IEPA licensed chem site to the west of the LLW site is not contributing organic contamination to the onsite groundwater. However, leaching from the unlicensed burial area to the north of the LLW site has a significant impact on groundwater quality in the site vicinity.

Low concentrations in well USE-150 indicate that the IEPA licensed site is not contributing significant organic contamination to groundwater beneath the LLW site. Based on the USGS water table contour map (see Fig. 5), well USE-150 is upgradient of the LLW trenches and downgradient of the chem site. In particular, this well is upgradient of the Trench 18 sump which exhibits high organic content. TOC concentration is in the background range and tritium is below detection in this well. Five organics are detected in this sample, but the highest concentration is only 6 μg/l (Table 6). Only well 574, the background well, indicates fewer detected organics.

Concentrations in onsite well USGS-534 also support this conclusion. Well 534 is located on the northern border of the site and intercepts groundwater from the north and west of the site. As above, the TOC concentration is in the background range and tritium is below the detection limit. Five organics are identified, all below the detection limit of 1 μg/l. The USGS detected no organics in wells 533 and 535, which are north of the northern most LLW disposal units, Trench 18, and Trench 23, respectively, further supporting the hypothesis that the LLW disposal units are not the source of organic contamination in this area.

Results of previous sampling by USGS and IEPA (Table 7; Appendix B) also indicate organic contamination from the unlicensed burial area only, and not from the chem site. Wells USGS-511 and USGS-519 are also located upgradient of the LLW trenches and downgradient of the chem site (Fig. 9). Only USGS-519, which is very close to Trench 18, contained detectable levels of organic chemicals (Table 6) suggesting that the trench may be the contaminant source. The sample from this well also exhibited an "oil sheen" and "diesel fuel like odor." This, in combination with a reported aliphatic hydrocarbons concentration of 3900 μg/l, suggests contamination from petroleum product. In addition, no organics were detected in 511 and USE-150, supporting the conclusions of the present study, that significant organic contamination of the groundwater beneath the LLW site is not caused by the chem site.

The impact of the unlicensed burial area on groundwater quality is also shown in previous USGS and IEPA sampling results for several USGS wells north of the LLW site: 513, 514, 515, and 516 (Fig. 9, Table 7). Well 513 is downgradient from and closest to the chem site and did not exhibit organic constituents. The sample from 515, next downgradient, exhibited a "peculiar odor" and an "oil like film." Chloroform, trichloroethane, tetrachloroethylene, and methylene chloride were detected in this sample. However, samples taken from well 514 yielded no organics detected by the USGS, and only 2 μg/l tetrachloroethylene in the IEPA sample . IEPA's sample also indicated a "fuel like odor." While

Table 7 Partial results of previous USGS and IEPA groundwater sampling at the Sheffield site

Well ID and Sampling Agency	Date	Results as reported by sampling agency
USE-150 IEPA	11/17/83	PCB's <0.1 µg/l no extractable organics detected no volatile organics detected
USGS-511 IEPA	11/17/83	PCB's <0.1 µg/l aliphatic hydrocarbons 3 µg/l no volatile organics detected
USGS	7/19/84	no organics detected above 3 µg/l
USGS-519 IEPA	11/17/83	PCB's not detected aliphatic hydrocarbons 3900 µg/l no volatile organics detected (trace acetone) several unidentified compounds
USGS-513 IEPA	11/17/83	PCB's <0.1 µg/l alphatic hydrocarbons 3 µg/l no volatile organics detected
USGS-514 IEPA	11/17/83	PCB's <0.1 µg/l alphatic hydrocarbons 140 µg/l tetrachloroethylene 2 µg/l
USGS	7/19/84	no organics detected above 3 µg/l
USGS-515 IEPA	11/17/83	PCB's <0.1 µg/l alphatic hydrocarbons 5 µg/l chloroform 5 µg/l; 1,1,1-trichloroethane 13 µg/l tetrachloroethylene 18 µg/l methylene chloride 1 µg/l
USGS-516 IEPA	11/17/83	PCB's <0.1 µg/l no extractable organics detected chloroform 180 µg/l; 1,1,1-tichloroethane 3 µg/l tetrachloroethylene 1000 µg/l methylene chloride 4 µg/l; dichloroethylene 3 µg/l 1,2-dichloroethane 2 µg/l; trichloroethylene 20 µg/l carbon tetrachloride 4 µg/l
USGS	7/19/84	chloroform 200 µg/l tetrachloroethylene 1000 µg/l trichloroethylene 19 µg/l 1,1-dichloroethylene 5.5 µg/l
USE-P IEPA	11/17/83	1,1,1-trichloroethane 6 µg/l; xylene (5/83) 16 µg/l dichloroethylene 1 µg/l; PCB's 0.6 µg/l
USE-C-1 IEPA	11/17/83	methylene chloride 2 µg/l; tetrachloroethylene 11 µg/l chloroform 2 µg/l; PCB's (3/82) 29 µg/l alphatic hydrocarbons 100 µg/l

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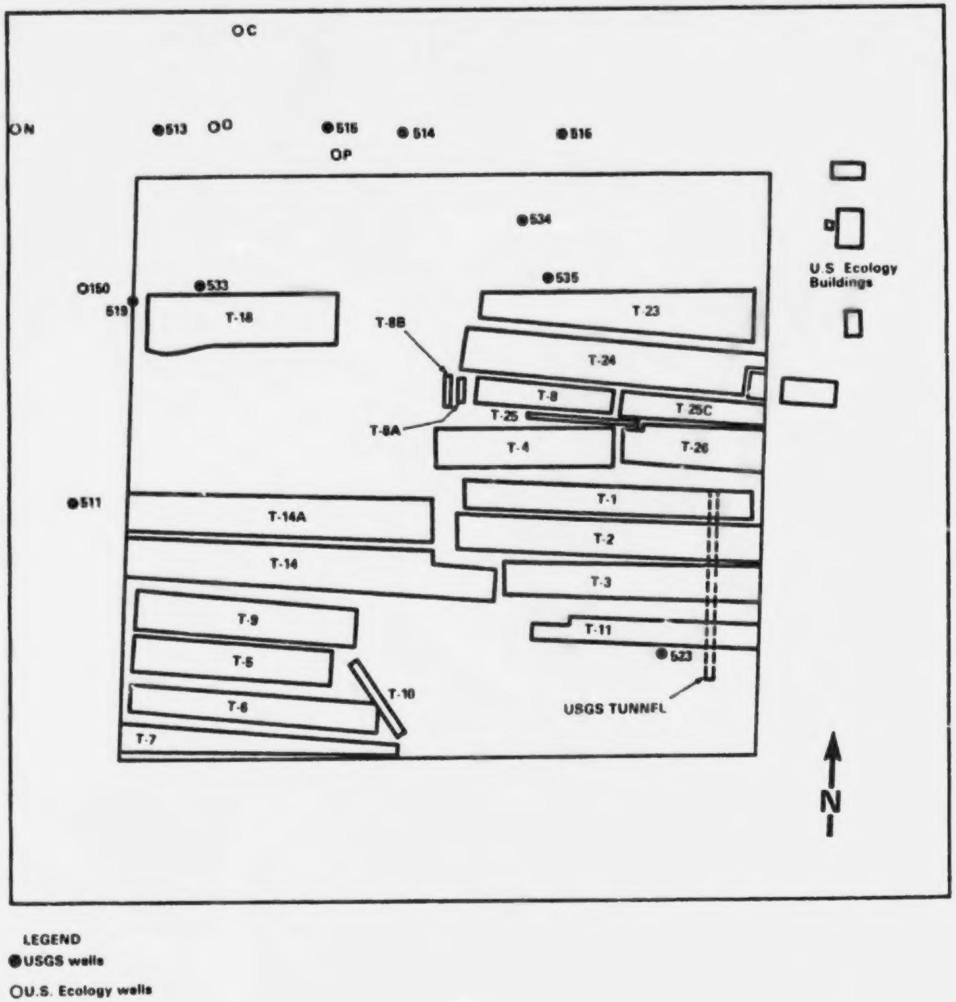


OC
ON
●513
OO
●515
●514
●516
OP
●534
U.S Ecology Buildings
O150
●533
●535
519
T-18
T-8B
T-23
T-24
T-8
T-25C
T-25
T-8A
T-4
T-26
●511
T-14A
T-1
T-2
T-14
T-3
T-9
T-11
●523
T-5
T-10
T-6
USGS TUNNEL
T-7
N
LEGEND
●USGS wells
OU.S. Ecology wells

Figure 9. Locations of Sheffield wells previously sampled for organics

the other USGS wells in this area are screened only in the Teneriffe silt and underlying shale, well 514 is also screened in the Hullick Till unit. This and other factors, such as spatial variability or nonuniform release, may account for the lower concentrations at 514. Samples from well 516, further downgradien yielded 1 mg/l tetrachloroethylene (both USGS and IEPA). This supports the hypothesis that a significant portion of the organics detected in this area north of the site are from the chemical waste buried in this area. The increas in concentrations from well 513 to 515 to 516 (well 514 does not follow this trend) also suggests that the IEPA licensed hazardous waste disposal facility is not a current source of contamination.

Four USE wells in the area north of the LLW site were also sampled by IEPA (Fig. 9, Table 7). Notably, PCB's were detected in all of these wells but were not detected in any USGS wells located between these wells. Toluene was detected in well C-1, in the unlicensed burial area, farthest from the LLW site and xylene was detected only in well P. Toluene and xylene are constituents of petroleum products, are mobile in groundwater, and are associated with organic contamination from industrial waste disposal (cf. Reinhard et al. 1984).

Contamination from major mixed waste streams identified in a survey by Brookhav National Laboratory (BNL) is not indicated in groundwater at the Sheffield LLW site. Major waste streams identified as possibly constituting significant RCRA hazardous waste occurring in LLW include: liquid scintillation media (primaril containing toluene and xylene, also some dioxane); chromate wastes from reactor and lead, primarily used as shielding at reactors (Bowerman et al. 1985; Kempf et al. 1986). Notably, the chemicals associated with these waste streams, toluene, xylene, chromium, and lead, are at or below detection limits or at bacground levels for the sampled locations at the Sheffield LLW site.

The problem of organic contamination is not unique to the Sheffield site; it occurs at waste disposal facilities of all types, hazardous as well as non-hazardous. The nonradiological chemical constituents which appear in elevated levels at Sheffield are primarily industrial solvents which are common groundwater contaminants: trichloroethane, trichloroethylene, dichloroethane, tetrachloroethylene, and chloroform. In an EPA sampling of finished drinking water from municipal water supply systems using groundwater, the most frequent found volatile organic compounds were trihalomethane (associated with chlorination), trichloroethylene, trichloroethane, tetrachloroethylene, dichloroethyle and dichloroethane (Westrick et al. 1984).

Because no groundwater pumping occurs in the area between the Sheffield LLW site and the strip mine lake, there does not appear to be an immediate public health concern at the site. All groundwater beneath the site discharges to th strip mine lake (Garklavs and Healy 1985) where any contaminants entering this water body are diluted to a large extent.

D. Conclusions

The following preliminary conclusions are made:

- The overall extent of organic chemical contamination of groundwater at th Sheffield LLW facility is significant. The highest concentrations of identified organic contaminants are over 1 mg/l. Concentrations of seve organics exceed EPA's proposed drinking water standards. Hydrocarbons associated with petroleum products are also identified.

- There does not appear to be a public health concern at the Sheffield LLW site due to nonradiological constituents being released to groundwater because site groundwater is not used for water supply.

- The occurrence of organics onsite and to the east of the site follows the general pattern of tritium occurrence. Total organic carbon and 1,1,1-trichloroethane are positively correlated with tritium concentrations for onsite wells and wells in the offsite tritium plume. This indicates that organic contaminants are being released to groundwater from the LLW disposal units.

- The sampling results do not indicate that contamination from toluene and xylene scintillation liquids, chromate wastes, or lead is occurring at the Sheffield LLW site. Several industrial solvents, typical of groundwater contamination from waste disposal, are present in significant concentrations. Toluene, xylene, and hazardous metals concentrations are at or below detection limits or at background levels.

- These results and previous USGS and IEPA sampling results indicate that organic chemicals are not entering the LLW site groundwater system from the IEPA licensed hazardous waste disposal facility across the LLW site's western boundary, but that the unlicensed chemical burial area north of the LLW site is a source of organic contamination.

- The downhole bailer with an enclosed vial prevented loss of volatile organics and should be utilized for these samples. When the concentrations of individual organics are required, standard EPA/RCRA analysis procedures are preferred over the method 8600 screening methodology.

Only limited data have been collected to assess nonradiological contamination of groundwater at the Sheffield LLW site. Therefore, these conclusions must be considered preliminary in nature.

III. BARNWELL SAMPLING PROGRAM AND RESULTS

A. Background

The Barnwell low-level radioactive waste (LLW) disposal facility was chosen for the mixed waste sampling program because it is an example of an operating commercial LLW facility using waste classification, waste segregation and, to the extent practical, operating procedures required in 10 CFR Part 61, NRC's rule for LLW disposal. Unlike the other two operating sites, numerous groundwater monitoring wells are available to sample the relatively shallow saturated zone. The site is located in Barnwell County, South Carolina, adjacent to the Savannah River Plant (SRP) (Fig. 10). The facility is operated by Chem-Nuclear Systems Inc. (CNSI), and currently receives about one-half of the commercial LLW generated in the United States. Liquid scintillation vials containing toluene and xylene have not been disposed of at Barnwell since 1978 (NRC 1982).

The Barnwell site is underlain by about 1000 ft of unconsolidated formations, the deepest of which comprises the regional Tuscaloosa Aquifer system (Fig. 11). This aquifer is separated from shallower sand units of the Congaree and McBean Formations by a 50-80 ft thick clay layer in the Ellenton Formation. The McBean Formation is overlain by the sandy clays of the Hawthorn and Barnwell Formations. Up to several feet of wind blown sands overlie the Hawthorn Formation (Cahill 1982).

The site is located in the humid Atlantic Coastal Plain and the mean annual precipitation is about 47 inches. Because the surficial sediments are sandy, very little surface runoff from the site occurs; most precipitation evapotranspires while the remaining 30 to 40 percent infiltrates to the underlying sediments through surficial depressions and Carolina Bays (circular surface depressions of undetermined origin) which are flooded after rainfall. Perched zones occur above the water table in clayey portions of the Barnwell and Hawthorn Formations. These units recharge the sands of the Congaree and McBean Formations which are water supply aquifers in the local area. These units in turn recharge the underlying Tuscaloosa Aquifer system through the leaky clay layer of the Ellenton Formation.

The Tuscaloosa Aquifer is a major source of domestic and industrial water and has an estimated transmissivity of about 22,000 ft^2/day (Cahill 1982). Siple (1967) considered that the primary regional recharge mechanism of the Tuscaloosa Aquifer was leakage through the confining clays of the Ellenton Formation. Cahill (1982) evaluated the hydrogeology of the site and vicinity, concentrating on units within 500 ft of the land surface. Cahill, disagreeing with Siple, conceptualized the clays of the Ellenton Formation as an impermeable bottom in his model of the shallow flow system. The extent of leakage through this confining unit to the Tuscaloosa Aquifer is currently unresolved and may be important in assessing long-term performance of the site. Groundwater in the Tuscaloosa Aquifer flows west-southwest to discharge locations at pumping centers and along the Savannah River (Siple 1967).

Groundwater flow in the surficial units (Cahill's zones 1, 2, and 3) is generally to the southwest towards Mary's Creek, a spring fed perennial stream about 3,000 ft south-southwest of the closest disposal units (Fig. 12 from Cahill 1982).

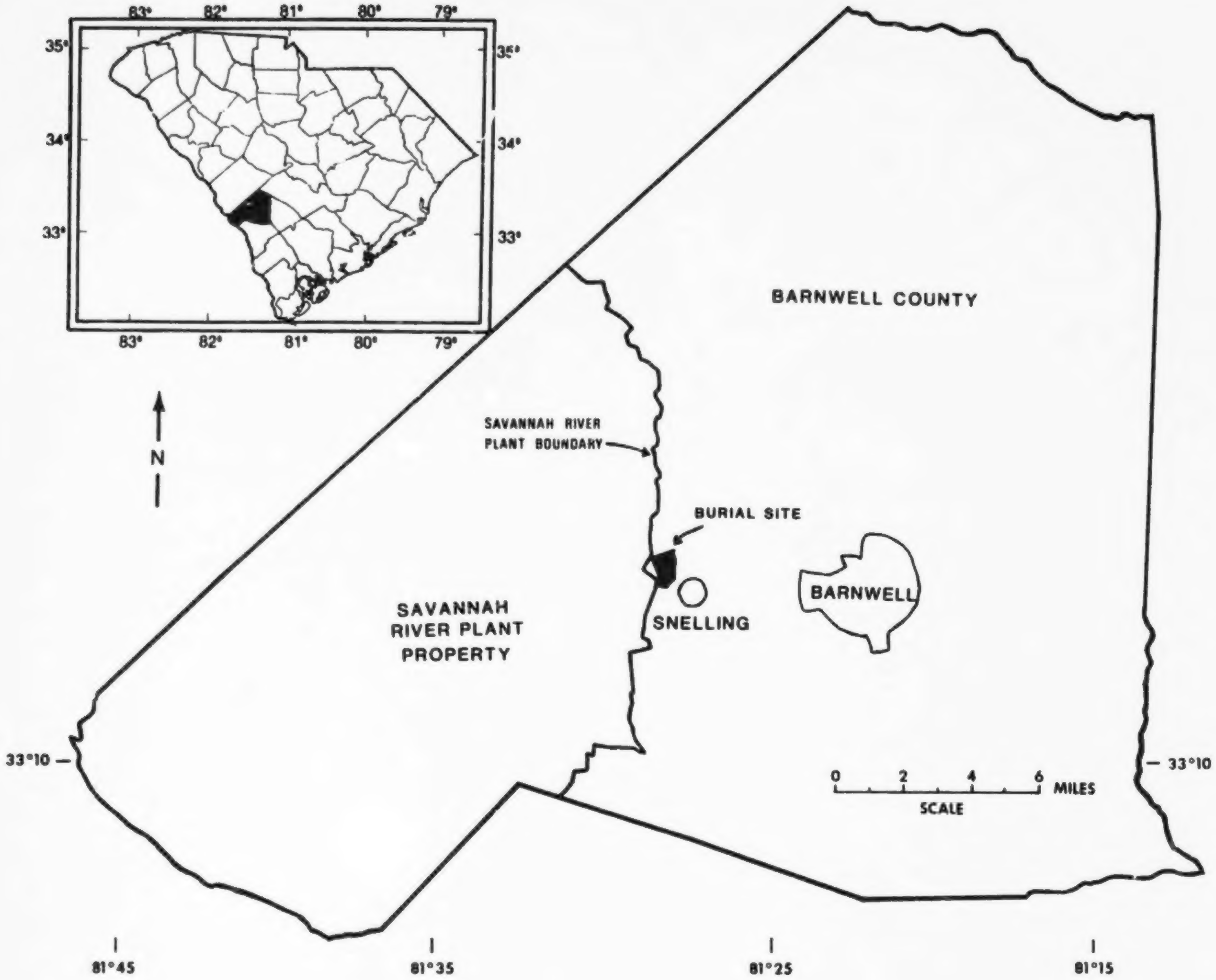

83°
82°
81°
80°
79°
35°
34°
33°
N
BARNWELL COUNTY
SAVANNAH RIVER PLANT BOUNDARY
BURIAL SITE
SNELLING
BARNWELL
SAVANNAH RIVER PLANT PROPERTY
33°10
0
2
4
6
MILES
SCALE
81°45
81°35
81°25
81°15

Figure 10. Site location of Barnwell LLW disposal facility (from Cahill 1982)

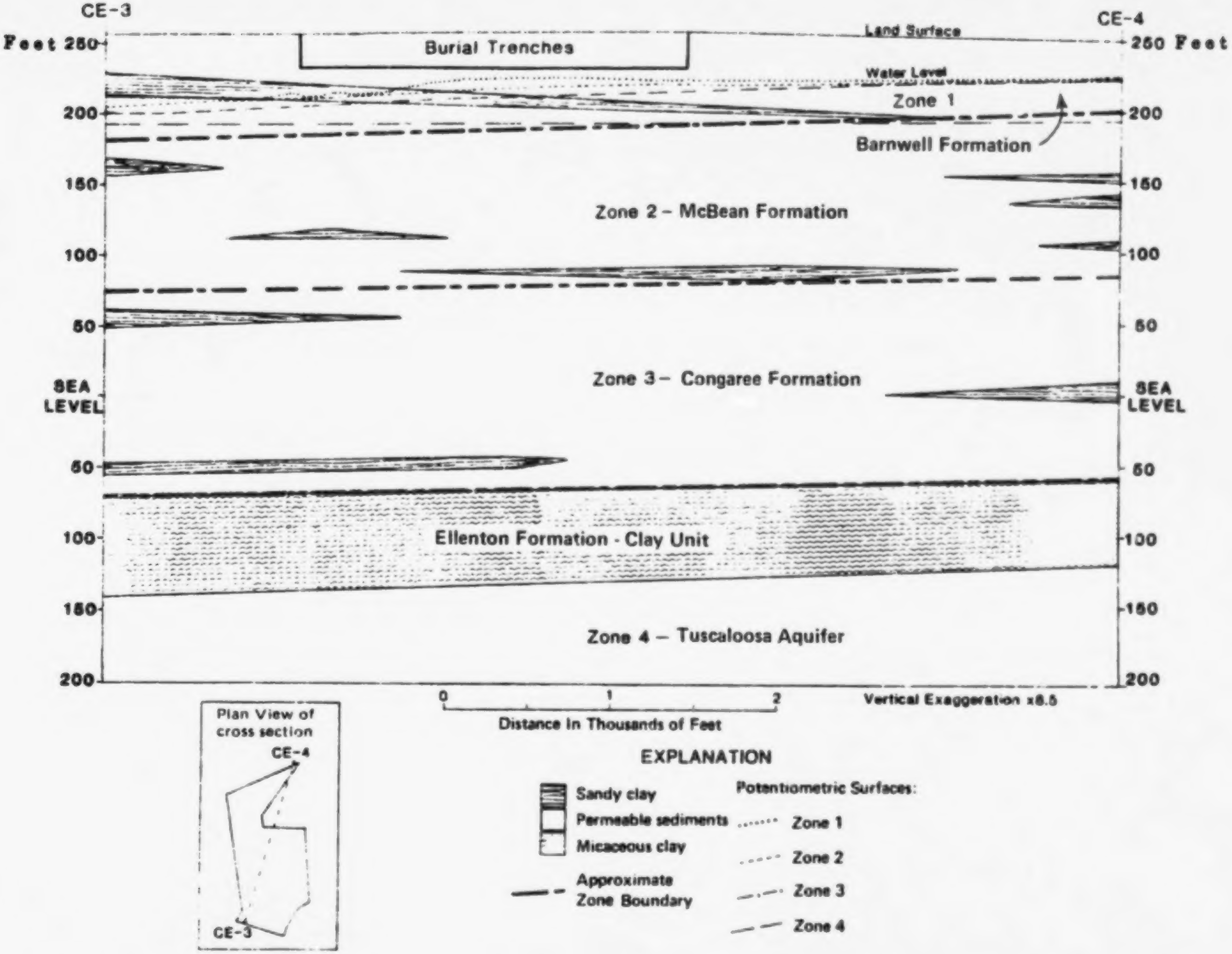
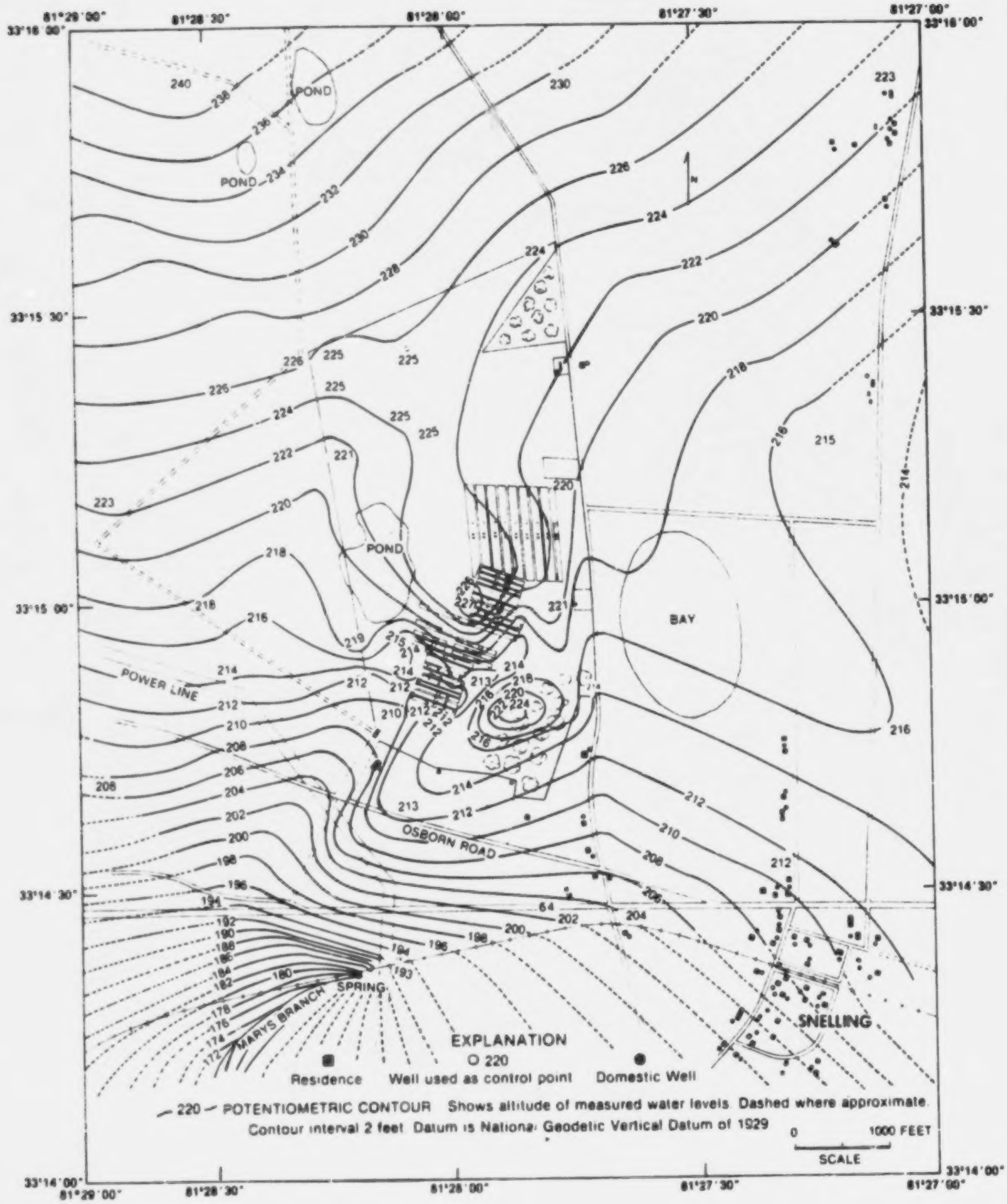

CE-3
CE-4
Feet 250
250 Feet
Land Surface
Burial Trenches
Water Level
Zone 1
200
Barnwell Formation
150
Zone 2 – McBean Formation
100
50
Zone 3 – Congaree Formation
SEA LEVEL
50
Ellenton Formation - Clay Unit
100
150
Zone 4 – Tuscaloosa Aquifer
200
0
1
2
Distance In Thousands of Feet
Vertical Exaggeration x8.5
Plan View of cross section
EXPLANATION
Sandy clay
Permeable sediments
Micaceous clay
Approximate Zone Boundary
Potentiometric Surfaces:
Zone 1
Zone 2
Zone 3
Zone 4

Figure 11. Geologic section showing representative stratigraphy for Barnwell site (after Cahill 1982)


81°29'00"
81°28'30"
81°28'00"
81°27'30"
81°27'00"
33°16'00"
33°15'30"
33°15'00"
33°14'30"
33°14'00"
POND
POND
POND
BAY
POWER LINE
OSBORN ROAD
SPRING
MARYS BRANCH
SNELLING
240
238
236
234
232
230
228
226
225
224
223
222
221
220
219
218
216
215
214
213
212
210
208
206
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200
198
196
194
193
192
190
188
186
184
182
180
178
176
174
172
EXPLANATION
Residence
O 220
Well used as control point
Domestic Well
— 220 — POTENTIOMETRIC CONTOUR Shows altitude of measured water levels. Dashed where approximate.
Contour interval 2 feet. Datum is National Geodetic Vertical Datum of 1929
0
1000 FEET
SCALE

Figure 12. Contour map of November 1979 water table elevation, Barnwell site (from Cahill 1982)

Elevated tritium levels in a monitoring well 10 ft from Trench 8 (WM-0040) screened at a depth of 40 ft have indicated migration from the trenches to the shallowest groundwater (Cahill 1982). Czyscinski and Weiss (1981) found elevated tritium levels in soil cores more than 3 m (about 10 ft) below trench bottoms. More recent data indicates further vertical and horizontal migration of tritium in groundwater (CNSI 1985; Appendix E).

Limited sampling and analysis previously performed by Brookhaven National Laboratory (BNL), U.S. Geological Survey (USGS), South Carolina Dept. of Health and Environmental Control (SCDHEC), and the operator (see Appendix C) have detected organic constituents above background concentrations in and adjacent to disposal units. Investigators from BNL sampled trench water at the Barnwell facility under contract to NRC. Although specific organic constituents were not analyzed for, Czyscinski and Weiss (1981) presented organic carbon measurements for leachate from 7 trenches ranging from background levels, approximately 2 mg/l, to 200 mg/l; "The [trench] water quality reflected the interaction of groundwaters with the buried wastes and the effects of bacterial degradation of organic waste components." Weiss and Colombo (1980) reported dissolved organic carbon concentrations of 11 and 15 mg/l for shallow wells WM-0040 and WM-0022. Well WM-0040 is adjacent to WM-0039, which is sampled for the present study, but WM-0040 is screened at a shallower depth.

A preliminary nonradiological groundwater sampling program conducted by CNSI (1985) indicates elevated levels of toulene, xylene, and other constituents in onsite wells. These results are discussed below in Section III-C.

Groundwater quality at Barnwell is potentially affected by waste disposal and other activities at the adjacent SRP and the adjacent Allied-General Nuclear Services' nuclear fuel reprocessing plant which is not currently operating (see NRC 1976).

B. Sampling and Analysis Procedures

Five onsite wells (WM-0035, WM-0039, WM-0074, WB-0102, and WB-0802) were sampled on May 14, 1985 (Fig. 13; Appendix B). Well WB-0802 is on the eastern site boundary and is upgradient from the disposal units based on a Cahill's water table contour map (see Fig. 12). This is considered a background sampling location. Well WB-0102 is on the western site boundary directly downgradient from the disposal units. Wells WM-0039 and WM-0074 are adjacent to disposal units and WM-0035 is downgradient of WM-0039. Several of the originally proposed sampling locations (Appendix A) were not utilized; no trench sumps contained water at the time of this sampling and 2 proposed shallow wells were dry. CNSI also recommended 2 new boundary monitoring wells, as upgradient and downgradient locations, which were incorporated in the program.

Sampling was performed by R.H. Ketelle, J.T. Kitchings, and R.K. Owenby of Oak Ridge National Laboratory (ORNL) with the assistance of CNSI personnel. CNSI staff took simultaneous split samples at all wells except WM-0035 because this well contained little water prior to sampling and recovered very slowly after purging. All wells were bailed for 2-3 well volumes, while specific conductance and pH were monitored to indicate stability prior to sampling. Sample containers, with preservatives, were filled directly from the dedicated bailers. Filtering of metals samples were performed within 6 hours of sampling. The details of the sampling procedures are documented by Ketelle and others (1985; Appendix B).

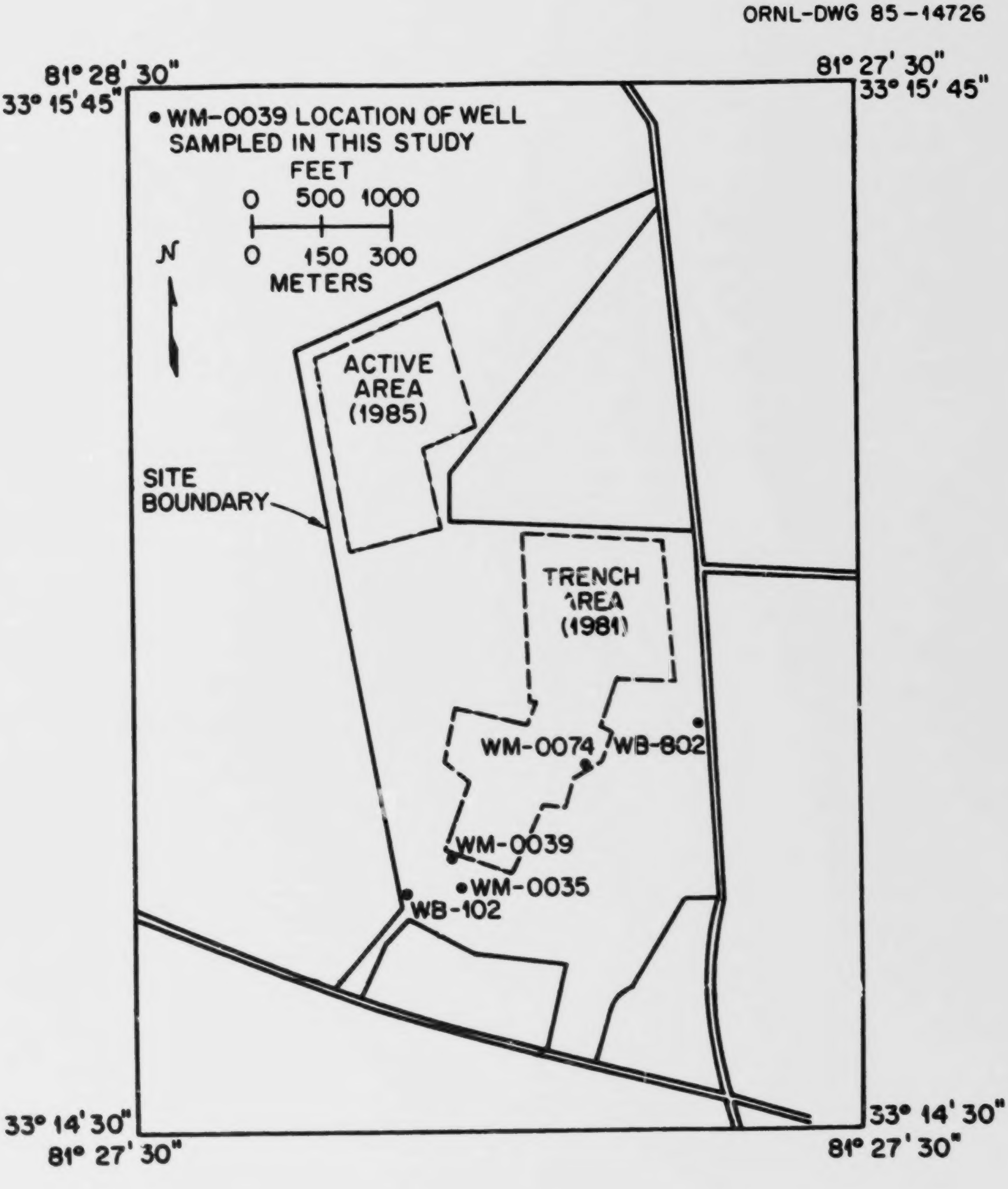
ORNL-DWG 85-14726
81° 28' 30"
33° 15'45"
81° 27' 30"
33° 15' 45"
• WM-0039 LOCATION OF WELL SAMPLED IN THIS STUDY
FEET
0 500 1000
0 150 300
METERS
N
ACTIVE AREA (1985)
SITE BOUNDARY
TRENCH AREA (1981)
WM-0074
WB-802
WM-0039
WM-0035
WB-102
33° 14'30"
81° 27' 30"
33° 14' 30"
81° 27' 30"

Figure 13. Barnwell site features and sample locations

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All analyses were performed at ORNL using EPA's proposed Method 8600 (HAP; EPA 1984) and standard EPA-RCRA methodologies for the determination of organic and hazardous metals concentrations. The HAP methodology prescribes several screening tests to determine what individual analyses should be performed. All other analyses (major ions, hazardous metals) were performed using EPA procedures (Ketelle et al. 1985; Appendix B). Two sets of field split samples and various spiked samples were also analyzed for Quality Assurance/Quality Control.

C. Results and Discussion

The detailed results of the sampling and analysis are reported by Ketelle and others (1985; Appendix B). Table 8 shows the concentrations of metals and anions in five wells with two field splits. Cation concentrations are shown in Table 9. Table 10 shows radioactivity levels and the concentrations of indicators TOX (total organic halogens) and TOC (total organic carbon).

Tritium levels indicate migration from the LLW disposal units; highest activities are observed in well WM-0039 adjacent to Trench 8. Well WM-0039 is perforated between 56 and 66 ft below the surface in the lower part of the Barnwell formation, part of Cahill's zone 2. Notably, Cahill (1982) reported that tritium had not yet migrated down to zone 2, in 1979. For the present study, the tritium concentration in WM-0039, in zone 2, is 2.3E6 pCi/l. The reported tritium level is near the detection limit at the upgradient boundary well (WB-0802), and is below detection at the downgradient boundary well (WB-0102). Tritium levels are consistent with previous recent measurements (CNSI 1985) indicating that the collected samples are representative of normal groundwater conditions.

In general, shallow groundwater at the Barnwell site is of good quality. Low concentrations at the boundary wells indicate that activities at the adjacent SRP and Barnwell Nuclear Fuel Plant have not affected groundwater beneath the LLW facility. Concentrations of cations, anions, and metals are similar at all wells. Chromium is detected (at the detection limit) at wells WM-0039 and WM-0074. The split for WM-0039 indicates a somewhat higher concentration that may be due to adjustment of the analytical results for spike recovery (see Ketelle et al. 1985). Lead concentrations are highest at wells WM-0035 (0.005 mg/l) and WM-0074 (0.006 mg/l). These concentrations indicate minimal effect of waste disposal activities on groundwater quality. Nitrate (NO_3) is highest at WB-0102 (16 mg/l), the downgradient well, which may reflect fertilizer application. Notably, the next highest nitrate concentration is observed at WM-0802 (9 mg/l), the upgradient well. Sulfide, which is below the detection limit at the upgradient well, is detected in low concentrations at the other wells. The highest manganese concentrations are observed at WM-0035 (0.016 mg/l) and WM-0039 (0.017 mg/l).

The organic indicator parameters TOC and TOX are low and very similar for all sampled wells. As these indicators suggest, very few organic constituents are observed above detection limits (see Appendix B). Chloroform is detected in all samples with the highest concentrations at WM-0039 (14 and 12 µg/l) and WM-0074 (8 µg/l). Tetrachloroethylene is detected in the sample from WM-0074 and in one of two samples from WM-0039. Trichloroethylene is also detected in only one of the two samples from WM-0039. Toluene is not detected in any of the 5 samples. Xylene was not analyzed for because it is not a standard RCRA

Table 8 Metals and anion concentrations in Barnell groundwater samples, 14 May 1985 (from Ketelle et al. 1985)

Parameter	Units of Measurement	Well WB-802	Well WB-802-1[a]	Well WB-102	Well WM-0035	Well WM-0074	Well WM-0039	Well WM-0039-1[a]
				Metals measured by atomic absorption				
Ag	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.0002
As	"	<0.001	b	<0.001	<0.001	<0.001	<0.001	<0.056[c]
Ba	"	<0.02	<0.02	<0.02	<0.02	<0.02	0.24	0.072
Cd	"	0.004	0.003	0.002	0.005	0.003	0.003	<0.0081[c]
Cr	"	<0.001	b	<0.001	<0.001	0.001	0.001	<0.022[c]
Cu	"	0.003	<0.01[c]	0.002	0.014	0.001	0.001	<0.075[c]
Pb	"	0.001	b	0.001	0.005	0.006	0.001	<0.01[c]
Ni	"	<0.005	<0.016[c]	<0.005	<0.005	<0.005	<0.005	<0.014[c]
Se	"	<0.001	b	<0.001	<0.001	<0.001	<0.001	0.0011[c]
Sb	"	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Hg	"	<0.00005	b	<0.00005	<0.00005	<0.00005	<0.00005	b
				Anions				
Br	"	<5	<5	<5	<5	<5	<5	<5
Cl	"	3	3	3	2	3	2	2
F	"	<1	<1	<1	<1	<1	<1	<1
CO_3	"	0	0	0	0	0	0	0
HCO_3	"	3	0	2	3	13	0	5
NO_2	"	<5	<5	<5	<5	<5	<5	<5
NO_3	"	9	9	16	<5	6	<5	<5
SO_4	"	<5	<5	<5	<5	<5	<5	<5
Cyanide	"	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Sulfide	"	<0.01	<0.01	0.01	0.03	0.07	0.02	<0.01

Table 9 Cation concentrations in Barnwell groundwater samples, 14 May 85
(from Ketelle et al. 1985)

Parameter	Units of Measurement	Well WB-802	Well WB-802-1[a]	Well WB-102	Well WM-003	Well WM-0074	Well WM-0039	Well WM-0039-1[a]
				Cations measured by inductive coupled pisma				
Al	mg/l	<0.2	b	<0.2	<0.2	<0.2	<0.2	b
B	"	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Be	"	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	0.008[c]
Ca	"	1.4	1.3	1.1	1.6	4.9	2.4	2.2
Co	"	<0.02	b	<0.02	<0.02	<0.02	<0.02	0.011[c]
Fe	"	<0.03	<0.001	<0.03	0.4	<0.03	<0.03	0.041[c]
Ga	"	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hf	"	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
K	"	0.1	<0.1	0.2	0.2	0.4	0.1	0.1
Li	"	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mg	"	0.52	0.5	1.3	0.13	0.28	0.2	0.19
Mn	"	<0.003	<0.016[c]	0.0072	0.016	0.0063	0.017	0.034[c]
Mo	"	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Na	"	2.1	2.2	2.2	1.4	1.8	1.3	1.6
P	"	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Si	"	2.7	2.7	2.8	2.2	2.0	2.7	2.8
Sr	"	<0.005	<0.005	0.01	<0.005	0.015	0.0062	0.0059
Ti	"	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
V	"	<0.03	<0.007	<0.03	<0.03	<0.03	<0.03	<0.006[c]
Zn	"	0.039	0.041	0.08	0.029	<0.02	0.073	0.095[c]
Zr	"	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06

[a] Samples WB-802-1 and WM-0039-1 are duplicate samples obtained for qual y assurance analyses.

[b] Recovery of spike to QA sample was less than 100%, therefore, no sampl concentration can be computed.

[c] Value is computed on the basis of remainder values in excess of 100% s ke recovery from QA sample. Refer to section for spike recovery data.

Table 10 Radiological analyses, total organic carbon, and total organic halides of Barnwell groundwater samples, 14 May 85 (from Ketelle et al. 1985)

Parameter	Well WB-802	Well WB-802-1	Well WB-102	Well WM-0035	Well WM-0074	Well WM-0039	Well WM-0039-1
Tritium	810±945	1188±972	<810	1674±999	2.7E4±1.9E3	2.3E6±8.1E4	2.3E6±8.1E4
Gross alpha	0.51±2.24	2.16±2.97	2.702.971	16.47±5.94	2.16±3.24	2.16±2.7	0.92±2.35
Gross beta	1.62±2.7	4.32±2.97	<2.7±2.97	9.45±3.51	0.76±2.62	2.7±2.97	1.62±2.7
Cs-137	<13.5	<13.5	<10.8	<10.8	<10.8	<8.1	<10.8
Co-60	<16.2	<13.5	<10.8	<8.1	<10.8	<13.5	<13.5

All values are pCi/L.

Parameter	Unit of Measurement	Well WM-0035	Well WM-0039	Well WM-0039-1[a]	Well WM-0074	Well WB-102	Well WB-802	Well WB-802-1[a]
TOC	mg/l	1.9	0.97	0.91	0.29	0.45	0.24	0.54
TOX	µg/l	10	7	7	5	7	7	10

[a] Samples WM-0039-1 and WB-802-1 are duplicate samples obtained for QA purposes.

scan constituent. No other organic constituents are observed above detection limits. These results indicate that the LLW disposal units have had a very minor effect on the nonradiological quality of onsite groundwater.

The sample from WM-0035 has a hydrocarbon content which might be related to petroleum products (Ketelle et al. 1985; Appendix B). Two fuel pumps are located about 50 ft to the southwest of WM-0035 and it is possible that fuel leaking from underground storage tanks migrated upgradient to this well due to heterogeneity of the near surface geology. CNSI (1985) indicated that the relative mixture of hydrocarbon components in this well was similar to gasoline (see Appendix E).

Results of a CNSI nonradiological monitoring program at 50 wells during 1982-1983 (see Appendix E) indicate organic chemical contamination at the site. Table 11 is CNSI's summary of benzene, toluene, xylene, and total volatiles concentrations in samples from onsite wells (CNSI 1985). Toluene and xylene were highest at WM-0035 which, as discussed above, may be contaminated by gasoline. However, these constituents were also detected at several other wells in significant concentrations. Total volatile measurements were high for several onsite wells. Chloroform, 1,2-dichloroethane, 1,1,1-trichloroethane, tetrachloroethylene, acetone, and isoproponal were detected in elevated concentrations. Concentrations of individual organics were typically less than 1 mg/l and several constituents were detected in only one or two wells. Organic constituent concentrations were very low at site boundary wells (WB series); the highest total volatiles was 11 μg/l, composed entirely of toluene. As discussed above, this contamination may be due to petroleum product. However, the reported occurrence of toluene and xylene in several onsite wells does indicate that these constituents have been released to groundwater from the disposal units, whether the source in the waste is petroleum product (absorbed oil, for example) or liquid scintillation media disposed of prior to 1978. Absence of toluene in samples taken for the present study (Ketelle et al. 1985; Appendix B) may indicate that variability in site hydrology or source release rates causes transient effects in nonradiological groundwater quality.

Groundwater from shallow aquifers is a water supply source in the site vicinity (Law Engineering 1970). Concentrations of nonradiological constituents at water supply wells, particularly those screened in shallow units, could be reviewed to assess whether or not there is a potential health and safety problem. These data were not reviewed for the present study. However, concentrations of individual organics are very low in onsite wells and are below detection at boundary wells (WB series).

D. Conclusions

The following preliminary conclusions are made:

- The overall extent of organic chemical contamination of groundwater at the Barnwell LLW facility is low. The highest organic constituent concentration from this study is 14 μg/l for chloroform in a well about 10 ft from a disposal unit. Previous efforts have found no organic chemical concentrations above 1 mg/l in groundwater.

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Table 11 Summary of benzene, toluene, xylene, and total volatiles concentrations (µg/l) in selected wells for CNSI study (1982-1983)(from CNSI 1985)

Sample Point	Benzene	Toluene	Xylene	Total Volatile Organics
WM-0019	8	<1	<1	32
WM-0021	<1	13	<1	30
WM-0022	<1	2	--	92
WM-0032	<1	2	<1	4
WM-0033	<1	2	2	13
WM-0034	1	7	11	33
WM-0035	<1	70	124	--
WM-0037	--	<1	3	--
WM-0039	8	<1	1	100
WM-0041	2	<1	1	8
WM-0042	<1	<1	<1	6
WM-0043	<1	<1	4	100
WM-0044	3	1	2	60
WM-0045	<1	1	2	22
WM-0046	<1	<1	2	8
WM-0047	<1	<1	2	14
WM-0048	--	1	1	--
WM-0049	--	--	--	--
WM-0050	<1	<1	2	91
WM-0051	1	<1	<1	5
WM-0052	<1	3	<1	20
WM-0054	<1	<1	5	430
WM-0055	<1	5	2	9
WM-0056	<1	8	1	35
WM-0057	<1	<1	<1	14
WM-0070	<1	1	<1	6
WM-0071	<1	1	<1	4
WM-0072	<1	<1	<1	<1
WM-0073	1	2	<1	3
WM-0074	<1	2	<1	26
WM-0075	<1	<1	<1	20
WM-0089	<1	1	<1	40

- The occurrence of organic contamination in five onsite wells follows the same trend as tritium occurrence: organics (except for hydrocarbons in WM-0035) are detected in 2 wells with elevated tritium levels located adjacent to disposal units. Chromium and lead appear to be at background levels. Based on CNSI (1985) data, toluene and xylene, associated with liquid scintillation media and petroleum products, appear to have migrated from the disposal units to groundwater in the past. Toulene is not detected in the present study. Three common organic solvents, chloroform, tetrachloroethylene, and trichloroethylene are detected at very low concentrations in groundwater adiacent to waste disposal units.

- There is no apparent effect of activities at the adjacent SRP or Barnwell Nuclear Fuel Plant on the nonradiological quality of shallow groundwater beneath the site.

- For future sampling, wells close to disposal units are the only ones likely to contain organic chemicals in measurable concentrations.

Only limited data have been collected to assess nonradiological contamination of groundwater at the Barnwell LLW facility. Therefore, these conclusions must be considered preliminary in nature.

IV. SUMMARY AND CONCLUSIONS

Groundwater sampling at low-level radioactive waste disposal sites indicates nonradiological contamination by organic chemicals, primarily organic solvents. At the Sheffield LLW site, organic solvents typical of groundwater contamination associated with municipal, industrial, and hazardous waste disposal are measured in significant concentrations. Three wells exhibit 1,1,1-trichloroethane concentrations over 1 mg/l. Concentrations of several organics exceed EPA's proposed drinking water standards. Hydrocarbons associated with petroleum products were also detected.

In groundwater samples from the Barnwell site, organic chemical concentrations are very low. Chloroform is detected in all wells at the Barnwell site in low concentrations, with a peak of 14 µg/l. Two other organic solvents are identified at or below detection limits in two wells adjacent to disposal units. The only other organic chemicals identified above detection limits were semi-volatile constituents associated with petroleum products. In a previous study by the facility operator, toluene and xylene were the organic chemicals whose concentrations were highest, although they are not detected in samples for the present study. At both these sites, results indicate that organic chemicals are being released by the LLW disposal units.

Previous samples from trench sumps and onsite wells at two other LLW sites have also indicated organic contamination from LLW. In particular, toluene and xylene have been detected, in addition to organic solvents. The xylene concentration is usually about one order of magnitude lower than the toluene concentration. Concentrations of these constituents typically drop over time indicating a relatively brief persistence in groundwater. Toluene and xylene are at or below detection limits at Sheffield and Barnwell in the present study.

An appropriate approach to regulating disposal of potentially hazardous waste mixed with LLW should consider that the groundwater contaminants identified at these sites are primarily organic solvents, and not other components identified in BNL's waste generator survey (Bowerman et al. 1985) as major mixed waste streams. For example, lead and chromium have not been detected above background levels at any LLW site.

The sampling program has also identified important considerations for future efforts. Analytical results for volatile organic chemical concentrations are very sensitive to the sampling method. To properly preserve these components, the special teflon bailer, with organics vial inside the bailer, should be used. Samples from wells closest to the disposal units are likely to contain higher concentrations than LLW site boundary wells, if contamination is present.

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APPENDIX A

PRELIMINARY SAMPLING PROGRAM

PRELIMINARY SAMPLING PROGRAM

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The Resource Conservation and Recovery Act (RCRA) mandates the Environmental Protection Agency (EPA) to regulate the disposal of hazardous substances with the exception of source, special nuclear and byproduct materials regulated under the Atomic Energy Act. Provisions in the regulations promulgated under the two acts have created confusion and uncertainty regarding the roles and responsibilities of NRC and EPA in regulating disposal of potentially hazardous non-radioactive constituents comingled with radioactive wastes. An Ad Hoc Task Group has been addressing this issue since February 1984. WMLU is currently revising a Task Plan which includes assessment of the hazardous non-radioactive component of generated LLW, and evaluation of disposal experience at existing LLW sites.

This preliminary sampling program is a part of the second half of the Task Plan on disposal experience, and has the specific objectives:

- Order of magnitude assessment of the migration of hazardous chemical constituents (RCRA) from LLW trenches at Sheffield and Barnwell
- Provide preliminary data to assess the need and scope for a comprehensive sampling program and other activities
- Provide insight on potential problems prior to comprehensive sampling
- Assist in optimizing sampling locations and analyses for the comprehensive sampling program.

For both Sheffield and Barnwell, 4 well samples and 1 trench sump sample will be analyzed for non-radioactive hazardous chemical constituents using EPA methodology. This methodology includes a screening method for all RCRA listed (Appendix VIII) organic compounds. The sampling and analysis will be performed by ORNL under an URFO contract. Dan Goode (WMGT) and Derek Widmayer (WMLU) will oversee the sampling at both sites.

PROPOSED SITES AND SAMPLING LOCATIONS

Sheffield, Illinois - Not receiving waste, U.S. Ecology, BNL recently performed trench inventory, site extensively monitored by USGS (100 wells), current USGS contract on site characterization and

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migration of tritium, trench 18 sump probably contains water, licensee reports than no significant toluene or xylene found in 9 onsite wells (1984), IEPA identified organics in several wells in trace quantities, hazardous waste site adjacent, unlicensed chemical waste site adjacent, WMLU and WMGT have been involved, NRC license under litigation (J. Shaffner, P.M.).

The proposed sampling locations are (see Figures A-1 and A-2):

1. Trench 18 sump, probably has water, near chem waste site, 'worst case' location
2. USGS 563, high tritium, NE in pebbly sand unit, fastest pathway, some organics identified
3. USGS 575, high tritium, NE in pebbly sand unit, closer to pond (further down-gradient) than 563
4. USGS 523, has high tritium, near Trench 11, not near chem site, (SE plume)
5. USGS 574, off-site, background (SE) near strip mine pond

alternates

6. USGS 592 (near 563) moderate tritium in NE plume
7. USGS 528 (523) moderate tritium
8. USGS 544 (trench 18) moderate tritium

Barnwell, South Carolina - Operating, Chem-Nuclear, about 46% of current U.S. volume, humid coastal plain, many wells onsite, migration of tritium, organics found in a soil core 10 ft from trench, Chem-Nuclear has monitored 86 sampling locations for certain chemical constituents over last 2 ½ yrs, WMLU expects data (report?) soon (1 month?), water table within 25 ft of ground, has SNM license from NRC (D. Widmayer, P.M., good relationship), Chem-Nuclear has own hydrogeologist, USGS (Cahill) has studied extensively, and continues to, BNL has sampled for organics.

The proposed sampling locations are (see Figures A-3 and A-4):

1. Trench 8 D1, high cobalt, tritium, beta (BNL data)
2. CN-4W, next to 4E, (32-42'), high tritium, migration from trench 8
3. CN-4E, near trench 8, (56-66') minor tritium
4. CN-1W, near trench 13, high concs of several constituents
5. GS-13, background, upgradient of trenches

alternates

6. Trench 5, high tritium, high organic carbon
7. CN-2 (shallow), near trench 8, high tritium
8. Trench 7, high tritium, beta, and alpha
9. CN-1E, (near 1W) shallow, 15 mg/l dissolved organic carbon
10. CN-5 or 6.

SAMPLING PROCEDURES

Sampling will be performed by R. Ketelle and one assistant from ORNL; D. Goode will be along for observation. In addition, D. Widmayer will observe at Barnwell site.

Stabilization - Wells will be purged to insure that sample represents ambient groundwater. For high K zones, monitor temperature, pH, E conductivity (flow-through system?) to assess stabilization (about 5 well volumes). For low K zones, pump dry 1 or 2 times, then take sample. Seperate pump for purging and sampling. Purge pump will be supplied onsite by licensee (or USGS, etc.).

Field measurements

- Temperature
- pH
- dissolved oxygen (with meter)
- specific conductance (meter)

Sampling will be performed with double valved teflon bailers or bladder pumps. Sample will be emptied (minimizing bubbling) into seperate glass or plastic containers with appropriate preservatives for each analysis. Aluminum foil will be placed inside volatiles container covers to prevent vapor transport. Samples will be placed immediately into cooler. At end of day, cooler will be express mailed to ORNL for analysis.

Sample quantity will be sufficient to perform analyses in triplicate (if necessary) and to perform QA/QC splits, etc.

Samples will be labeled in the field with Lab ID number only, this number will be recorded and correlated with well or trench sump number by ORNL and NRC staff. All procedures will be thoroughly documented (see attached sample form).

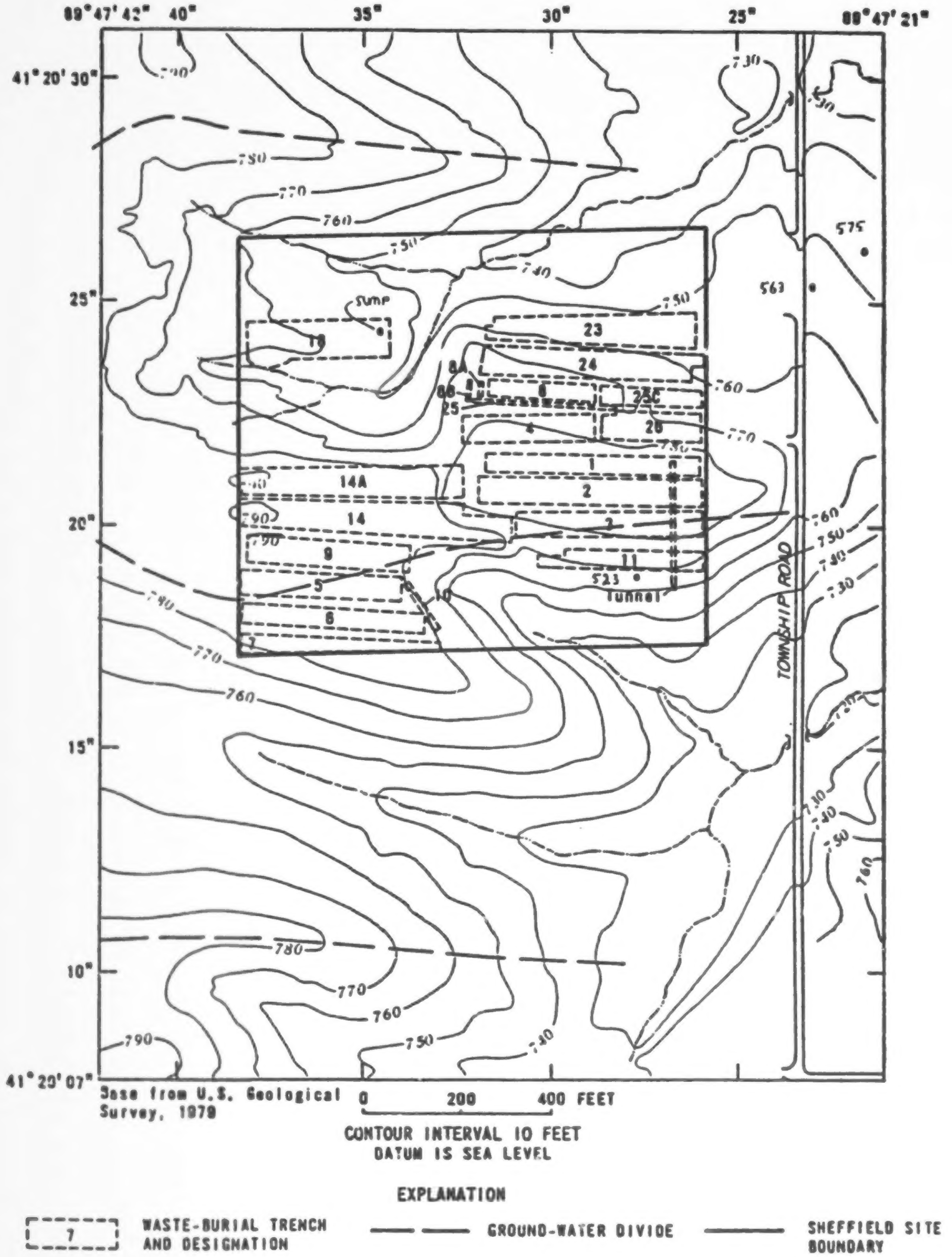
CHEMICAL ANALYSES

The attached table supplied by ORNL describes the analyses to be performed.

Proposed EPA Method 8600 will be used (FR 49-191:38786-38809, October 1, 1984). This method provides steps and criteria for screening samples for all listed (appendix VIII) organic constituents. In addition, certain samples will be analyzed for EPA hazardous metals, major cation/anions, TOC, TOX. Specific conductance and pH will be measured in the lab to compare to field values. Gross alpha, gross beta, and tritium will be measured for all samples to correlate to previous monitoring data.

QA/QC

Results will be delivered to NRC as letter report, containing documentation of all sampling and analysis procedures, numerical results with error bars, QA/QC documentation, including splits, and summary discussion.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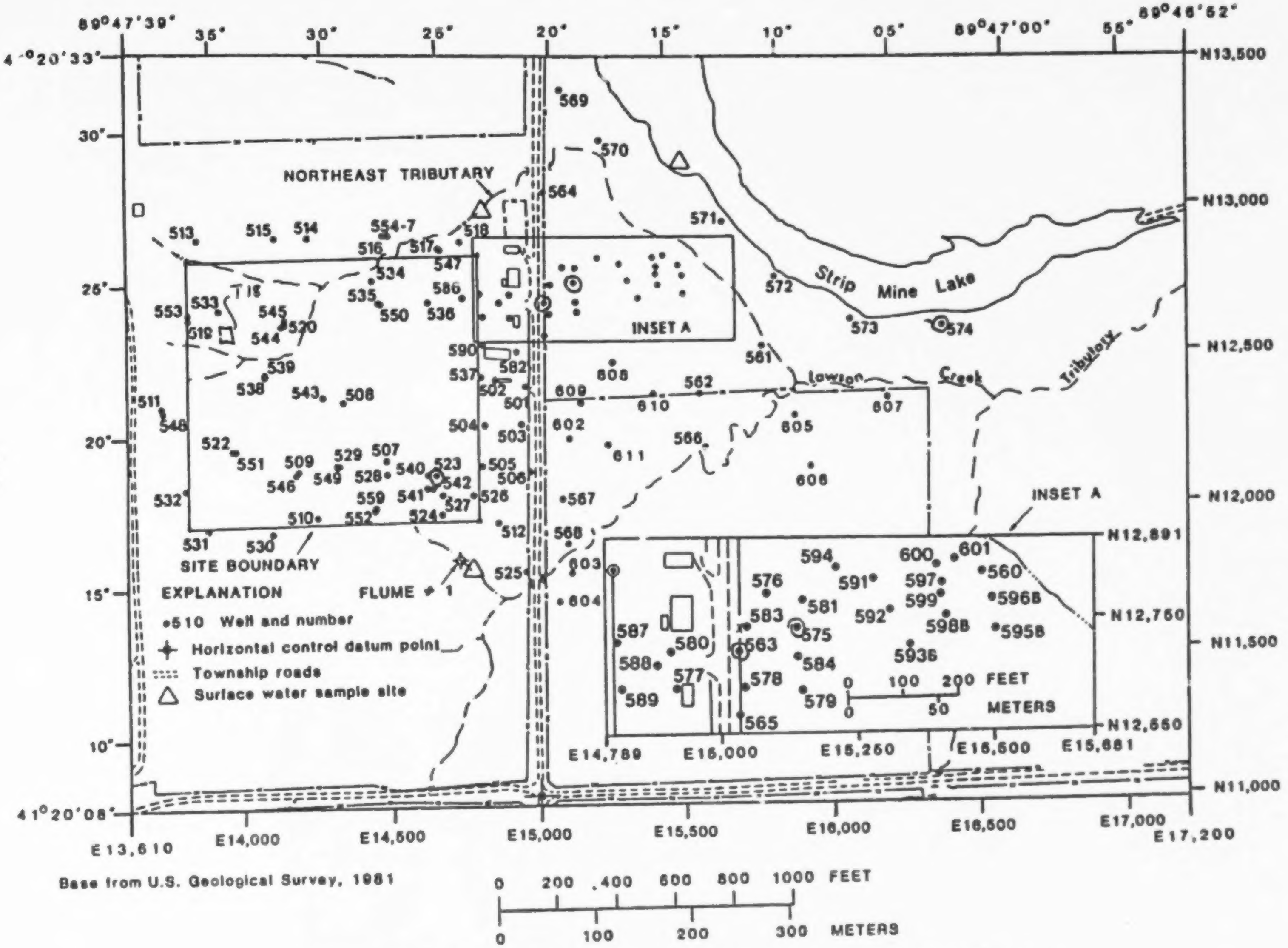
DATUM IS SEA LEVEL
EXPLANATION
7
WASTE-BURIAL TRENCH AND DESIGNATION
GROUND-WATER DIVIDE
SHEFFIELD SITE BOUNDARY

Base from U.S. Geological Survey, 1979

Figure A-1 Proposed sampling locations at Sheffield LLW site - close-up (after USGS).



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N12,000
N11,500
N11,000
E13,610
E14,000
E14,500
E15,000
E15,500
E16,000
E16,500
E17,000
E17,200
NORTHEAST TRIBUTARY
Strip Mine Lake
Lawson Creek
Tributary
INSET A
SITE BOUNDARY
FLUME # 1
EXPLANATION
•510 Well and number
Horizontal control datum point
Township roads
Surface water sample site
N12,891
N12,750
N12,650
E14,789
E15,000
E15,250
E15,500
E15,681
0 100 200 FEET
0 50 METERS
0 200 400 600 800 1000 FEET
0 100 200 300 METERS
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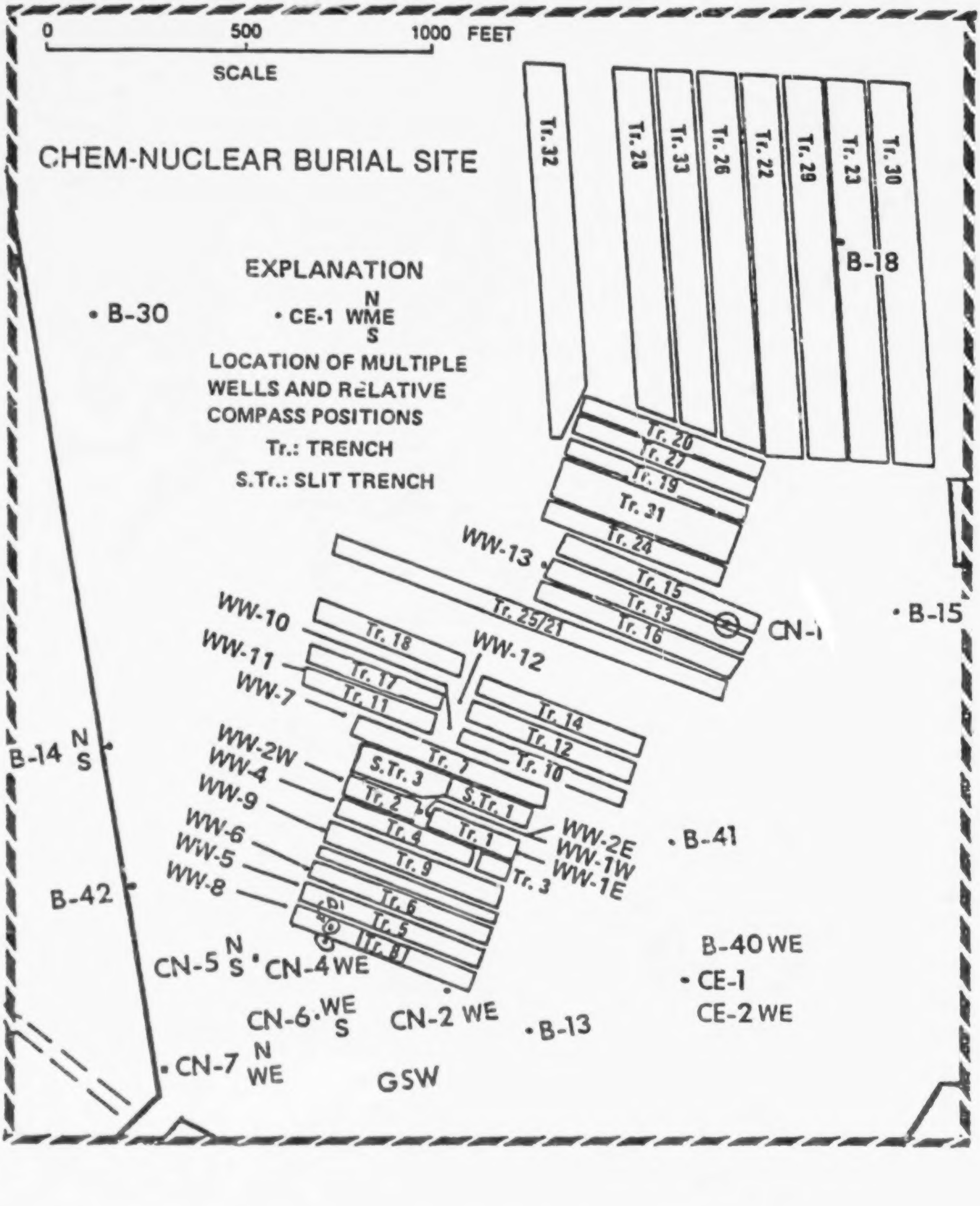
Base from U.S. Geological Survey, 1981

Figure A-2 Proposed sampling locations at Sheffield LLW site (after USGS).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500
1000 FEET
SCALE
CHEM-NUCLEAR BURIAL SITE
EXPLANATION
CE-1 N WME S
LOCATION OF MULTIPLE WELLS AND RELATIVE COMPASS POSITIONS
Tr.: TRENCH
S.Tr.: SLIT TRENCH
Tr. 32
Tr. 28
Tr. 33
Tr. 26
Tr. 22
Tr. 29
Tr. 23
Tr. 30
B-18
B-30
Tr. 20
Tr. 27
Tr. 19
Tr. 31
Tr. 24
Tr. 15
Tr. 13
Tr. 16
Tr. 25/21
WW-13
CN-1
B-15
WW-10
Tr. 18
WW-12
WW-11
Tr. 17
WW-7
Tr. 11
Tr. 14
Tr. 12
Tr. 10
Tr. 7
B-14 N S
WW-2W
WW-4
S.Tr. 3
S.Tr. 1
WW-9
Tr. 2
Tr. 1
Tr. 4
WW-6
WW-5
Tr. 9
Tr. 3
WW-2E
WW-1W
WW-1E
B-41
B-42
WW-8
Tr. 6
Tr. 5
Tr. 8
CN-5 N S
CN-4 WE
B-40 WE
CE-1
CE-2 WE
CN-6 WE S
CN-2 WE
B-13
CN-7 N WE
GSW

Figure A-3 Proposed sampling locations at Barnwell LLW site - close-up (after USGS).

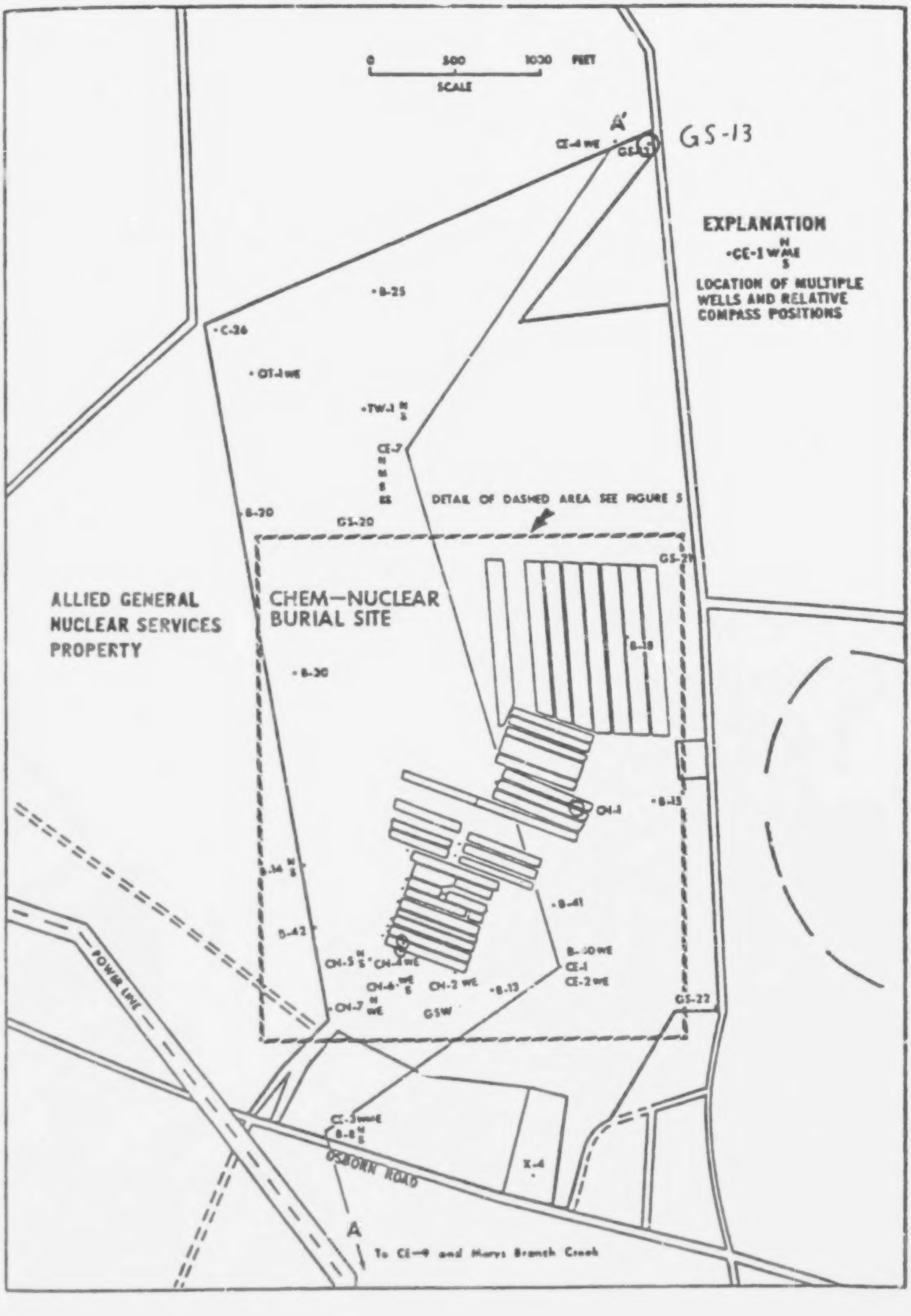
0 500 1000 FEET
SCALE
A'
CE-4 WE
GS-13
GS-13
EXPLANATION
•CE-1 W N/S E
LOCATION OF MULTIPLE WELLS AND RELATIVE COMPASS POSITIONS
•B-25
•C-26
•OT-1 WE
•TW-1 N/S
CE-7 N M S ES
DETAIL OF DASHED AREA SEE FIGURE 5
B-20
GS-20
GS-21
ALLIED GENERAL NUCLEAR SERVICES PROPERTY
CHEM—NUCLEAR BURIAL SITE
•B-30
B-10
CN-1
•B-15
B-14 N/S
•B-41
B-42
CN-5 N/S
CN-4 WE
B-10 WE
CE-1
CE-2 WE
CN-6 WE/S
CN-2 WE
•B-13
CN-7 N/WE
GSW
GS-22
POWER LINE
CE-3 WNE
B-8 N/S
OSBORN ROAD
X-4
A
To CE-9 and Marys Branch Creek

Figure A-4 Proposed sampling locations at Barnwell LLW site (after USGS).

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Table 1

Parameters, Analytical Methods, and Costs

Parameter	Method	Costs[a]
Hazardous Metals[b]		
Silver	Graphite Furnace AA	
Arsenic	"	
Barium	"	
Cadmium	"	
Chromium	"	
Copper	"	
Mercury	Cold Vapor AA	
Lead	Graphite Furnace AA	
Nickel	"	
Antimony	"	
Selenium	"	
Major Cations[b,c]	Inductive Coupled Plasma	
Major Anions[b,d]	Anion Chromatography	
Total Organic Carbon[b]		
Cyanides[b]	EPA 9010	
Sulfides[b]	EPA 9030	
Total Organic Halogen[b]	EPA 9030	
Halogenated Volatile Organics[e]	EPA 8010	
Non Purgeable Organics[e]	EPA 3560[f]	
Total Aromatics[e]	EPA 8610	
Total Nitrogen-Phosphorus[e]	EPA 8620	
Derivitization Procedures[e]	EPA 8630	
Non Halogenated Volatile Organics[e]	EPA 8015	
Acrolein, Acrylonitile. Acetonitrile[e]	EPA 8030	

[a] Cost in dollars per sample.
[b] Analysis for this parameter will be performed on all samples.
[c] Cations included in ICP analysis are included in Table 2.
[d] Anions included in Anion Chromatography analyses are included in Table 3.
[e] Analysis required only if indicated in performing 8600 Decision Matrix, cost includes contingency for positive identification of compounds.
[f] Method 3560 will be performed using an approved variation of Method 3560.

APPENDIX B

RESULTS OF RECONNAISSANCE EVALUATION OF HAZARDOUS CHEMICAL MIGRATION IN GROUND WATER IN THE VICINITY OF TWO LOW-LEVEL RADIOACTIVE WASTE DISPOSAL FACILITIES

by

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RESULTS OF RECONNAISSANCE EVALUATION OF HAZARDOUS CHEMICAL MIGRATION IN GROUND WATER IN THE VICINITY OF TWO LOW-LEVEL RADIOACTIVE WASTE DISPOSAL FACILITIES

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EXECUTIVE SUMMARY

A reconnaissance evaluation of ground water contamination by hazardous substances at two low-level radioactive waste disposal sites; the U.S. Ecology facility at Sheffield, Illinois, and the Chem-Nuclear facility at Barnwell, South Carolina, was performed for the U.S. Nuclear Regulatory Commission (NRC). Ground water sampling and analyses were performed by staff of Oak Ridge National Laboratory using procedures recommended by the U.S. Environmental Protection Agency.

At both sites, background wells and wells which have contained varying concentrations of tritium in previous monitoring activities were sampled. At the Sheffield site a sample was also obtained from a trench sump, but no trench sumps contained water at the Barnwell site.

Analytical results indicate that tritium is the principal mobile contaminant at both sites. At the Sheffield site, tritium levels exceed the drinking water limit in two downgradient wells located outside the perimeter of the disposal site area. At Barnwell, tritium levels exceed the drinking water limit in wells located adjacent to disposal trenches but do not exceed drinking water limits at a downgradient well located at the site boundary.

At the Sheffield site, significant concentrations (hundreds to thousands of parts per billion) of volatile organic compounds were detected in all the wells sampled. Identification of the source of volatile compounds is beyond the scope of this study. Semi-volatile compounds detected in samples from Sheffield include Di-N-Butyl pthalate, cyclohexene, dioxane, a glycol compound, and an unidentified chlorinated or oxigenated hydrocarbon. At Barnwell, only traces to low concentrations of volatile organic compounds were detected. Aliphatic hydrocarbons were detected in one well at Barnwell. None of the samples from either site showed concentrations approaching the EPA groundwater protection limits for EPA listed inorganic metals.

RESULTS OF RECONNAISSANCE EVALUATION OF HAZARDOUS CHEMICAL MIGRATION IN GROUND WATER IN THE VICINITY OF TWO LOW-LEVEL RADIOACTIVE WASTE DISPOSAL FACILITIES

1.0 INTRODUCTION

The purpose of the work reported here was to perform a reconnaissance evaluation of hazardous constituent migration from low level radioactive waste disposal trenches at two sites. Hazardous constituents are defined by and listed in Appendix VIII of the Environmental Protection Agency Resource Conservation and Recovery Regulations (40 CFR 260). The two sites sampled were the U.S. Ecology facility at Sheffield, Illinois, and the Chem-Nuclear facility at Barnwell, South Carolina. Both sites began operation prior to promulgation of the NRC regulations (10 CFR Part 61) for low-level radioactive waste disposal. These two sites were selected for study by the U.S. Nuclear Regulatory Commission.

The scope of work performed included:

- Visiting each site to obtain ground water samples from five wells at each site.
- Placing samples in appropriate containers with apropriate chemical and physical preservatives.
- Maintaining chain of custody documents on each sample.
- Transporting samples from the site to analytical facilities at Oak Ridge National Laboratory.
- Performing and reporting the required analyses.
- Providing quality assurance measures in the analytical program.

Preferred and alternative wells were selected by the NRC staff on the basis of past monitoring data. Upon arrival at each site, a determination was made as to the feasibility of sampling from the preferred wells. Factors considered were present physical condition of the wells and the ability of each well to provide sufficient sample quantity within a reasonable recovery time.

This report includes a discussion of field and laboratory methods, presentation of results obtained at each site, and a discussion of the results.

2.0 METHODS

This section presents descriptions of general sampling procedures and field measurements, sample preparation procedures, analytical techniques, and quality assurance measures utilized in this study.

2.1 FIELD SAMPLING AND SAMPLE PREPARATION METHODS

Field procedures included measurement of water level and total depth of each well, hand bailing to purge the well, hand bailing of samples, and sample preservation and preparation for shipping.

2.1.1 Sampling Method and Field Measurements

Upon arrival at each sampled well, an initial water level measurement was made using a conductive probe to indicate the water level in the well. The total depth of the well was also measured with the probe. The volume of water in the well casing was then computed to indicate the required well purging volume.

At both sites (Sheffield and Barnwell) wells were purged of standing water within the casing by hand bailing. Dedicated bailers were available for all but one well at the Sheffield site and all wells had dedicated bailers at Barnwell. Wells were purged of approximately three casing volumes of water or were bailed dry and allowed to recover prior to sampling. At the Barnwell site, pH and specific conductance were measured periodically during well purging to evaluate stabilization of these parameters quality prior to sampling. At the Sheffield site, pH and conductance data were obtained at two of the wells. Due to subfreezing temperatures the other wells were purged as rapidly as possible prior to sampling. Well purging details are reported for specific wells in Section 3.

2.1.2 Sample Preparation Procedures

Ground water samples were transferred from the bailer to the appropriate sample containers in the field. Sample container type used, volume, and preservative are listed in Table 1. Sample containers and preservatives used are in accordance with EPA requirements (40 CFR Part 136). Samples analyzed for dissolved metals were filtered through a 0.45 micron filter at the site, prior to acidification to a pH less than 2 at the Sheffield site. At the Barnwell site, three samples were filtered and acidified in the field and the remaining samples (4) were filtered and acidified within six hours. Likewise, at the Sheffield site, samples for sulfides and cyanides were preserved with sodium hydroxide at the site and at Barnwell the preservative was added at the end of the day samples were collected. Chain of custody forms were completed for all samples on the day samples were collected and accompanied the samples through transport and analyses. A sample numbering system was developed which provided anonymity of the sample location while the samples were in the laboratory. All samples were stored on ice from the time of collection until they were transferred to refrigerators at Oak Ridge National Laboratory.

2.2 LABORATORY ANALYTICAL METHODS

In this section, inorganic, radiological, and organic analytical methods used in the study are described.

2.2.1 Inorganic Analytical Methods

Inorganic parameters analyzed included dissolved metals, anions, sulfide, and cyanide. Table 2 summarizes inorganic parameters, analytical techniques, and EPA designation. The EPA priority pollutant metals (Ag, As, Ba, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Se) were analyzed by graphite furnace atomic absorption using the techniques specified in Table 2. Inductively coupled plasma (ICP) was used to measure concentrations of other dissolved metals. Sulfide and cyanide analyses were performed using the indicated analytical techniques.

Table 1

Sample Containers, Preservatives, and Maximum Holding Times

Analysis	Container	Preservative	Maximum Allowable Holding Time
Metals	1-L p[a]	Filter prior to acidification HNO_3 to pH<2	6 months[b]
Cyanide	1-L p	Cool 4°C, NaOH to pH>12	14 days
Sulfide	1-L p	Cool 4°C, add zinc acetate plus sodium hydroxide to pH>9	7 days
Other Anions	1-L p	Cool 4°C	7 days
TOC	1-L p and 40 mL-G[c] with teflon-lined septum	Cool 4°C, HCl to Ph<2	28 days
Gross Alpha Gross Beta Gammas	2-L p	HNO_3 to pH<2	6 months
Tritium	1-L p		3 months
Total Nitrogen - Phosphorus Total Aromataics Non-Purgeable Organics Derivatization Products	2-L G with teflon cap	Cool 4°C, 0.008% $Na_2S_2O_3$	7 days
Volatile Organics	2-40 mL G with teflon-lined septum	Cool 4°C, 0.008% $Na_2S_2O_3$	7 days
Acrolein Acrylonitrite	2-40 mL G with teflon-lined septum	Cool 4°C, pH 4-5 with HNO_3	14 days

[a] Polyethylene

[b] Except for mercury for which maximum allowable holding time is 28 days.

[c] Glass

Source: 40 CFR 136, EPA Guidelines Establishing Test Procedures for Analysis of Pollutants Under the Clean Water Act, Friday, October 26, 1984, Federal Register, Vol. 49, No. 20.

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Table 2

Inorganic Analytical Methods

Parameter	Analytical technique	EPA designation
Ag	GFAA	272.1
As	Hydride	206.3
Ba	GFAA	208.2
Cd	GFAA	213.2
Cr	"	218.2
Cu	"	220.2
Pb	"	239.2
Ni	"	249.2
Se	Hydride	270.3
Sb	GFAA	204.2
Hg	Cold vapor AA	245.2
Al	ICP	200.7
B	"	"
Be	"	"
Ca	"	"
Co	"	"
Fe	"	"
Ga	"	"
Hf	"	"
K	"	"
Li	"	"
Mg	"	"
Mn	"	"
Mo	"	"
Na	"	"
P	"	"
Si	"	"
Sr	"	"
Ti	"	"
V	"	"
Zn	"	"
Zr	"	"
Br	IC	
Cl	"	
F	"	
CO_3	TA	310.1
HCO_3	"	"
NO_2	IC	
NO_3	"	
SO_4	"	
Cyanide		335.1
Sulfide		376.2

Notes: GFAA - Graphite Furnace Atomic Absorption
ICP - Inductively Coupled Plasma
IC - Ion Chromatography
TA - Total Alkalinity

2.2.2 Radiological Analytical Methods

Tritium was determined by counting 2-mL portions of each sample mixed with a scintillation cocktail on an automated liquid scintillation counter with automatic quenching correction. Gross alpha and gross beta determinations were made by evaporating 250 mL of samples on planchets and counting the planchets on an automatic alpha/beta system programmed to correct counting data for self absorption due to solids on the planchets. The gamma-emitting radionuclides (^{137}Cs and ^{60}Co) were determined by counting 900 mL contained in Marinelli beakers on Ge(Li) detectors interfaced to a multichannel analyzer for data acquisition.

2.2.3 Organic Analytical Methods

The analyses of these water samples for organic constituents was essentially a two-fold approach. The samples were initially screened by the Hierarchical Analytical Protocol (HAP) as outlined by the U.S. EPA (Ref. 2). This hierarchical approach is essentially a set of screening methods, listed in Table 3, which are applied in the sequence outlined in Figure 1. The idea behind such a screening approach is that if the sample being analyzed passes the various test points in the screen, specific lists of organic compounds can be considered absent from the sample. On the other hand, failing to pass the screen at a given test point indicated that organic compounds from a given class may be present. Such failures require further analytical testing not necessarily specified by the HAP. After completion of the initial screen, samples which failed the HAP screen were further analyzed by EPA Method 1625, (method for semi-volatile priority pollutants, Federal Register, October 26, 1984) and by a method for volatile organic compounds involving pentane extraction and a dual column capillary gas chromatographic separation utilizing both electron capture detection and flame ionization detection. Table 4 lists the priority pollutant volatile compounds which are detected and quantitated by this method along with their detection limits. The semi-volatile compounds detected and quantitated by EPA Method 1625 are listed in Table 5. Table 6 identifies the classes or organic compounds included in the various tables accompanying the HAP.

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Table 3

Summary of HAP Methods to Screen for Organic Constituents in Water

EPA Method No.	Description	Tables Eliminated[a]
9020	Total Organic Halides	3A,3B
8010	Halogenated Volatile Organics	3A
3560	Reversed Phase Cartridge	b
8610	Ultraviolet Absorption	4,5,8,9
8620	Total Nitrogen-Phosphorus (Specific detection by Gas Chromatography)	6,7
8015	Non-halogenated Volatile Organic Constituents	8
8030	Heated Purge and Trap (Acrolein, Acrylonitrile, and Acetonitrile)	
8630	Derivitization procedure to convert compounds to Ultraviolet Absorbers	b

---

[a] The Appendix VIII procedures list 10 different Tables of compounds. Tables 3A, 3B, 4, ..., 9 list different classes of Organic Compounds as indicated in Table 6.

[b] No tables are eliminated by this method, it is a sample preparation procedure for other methods.

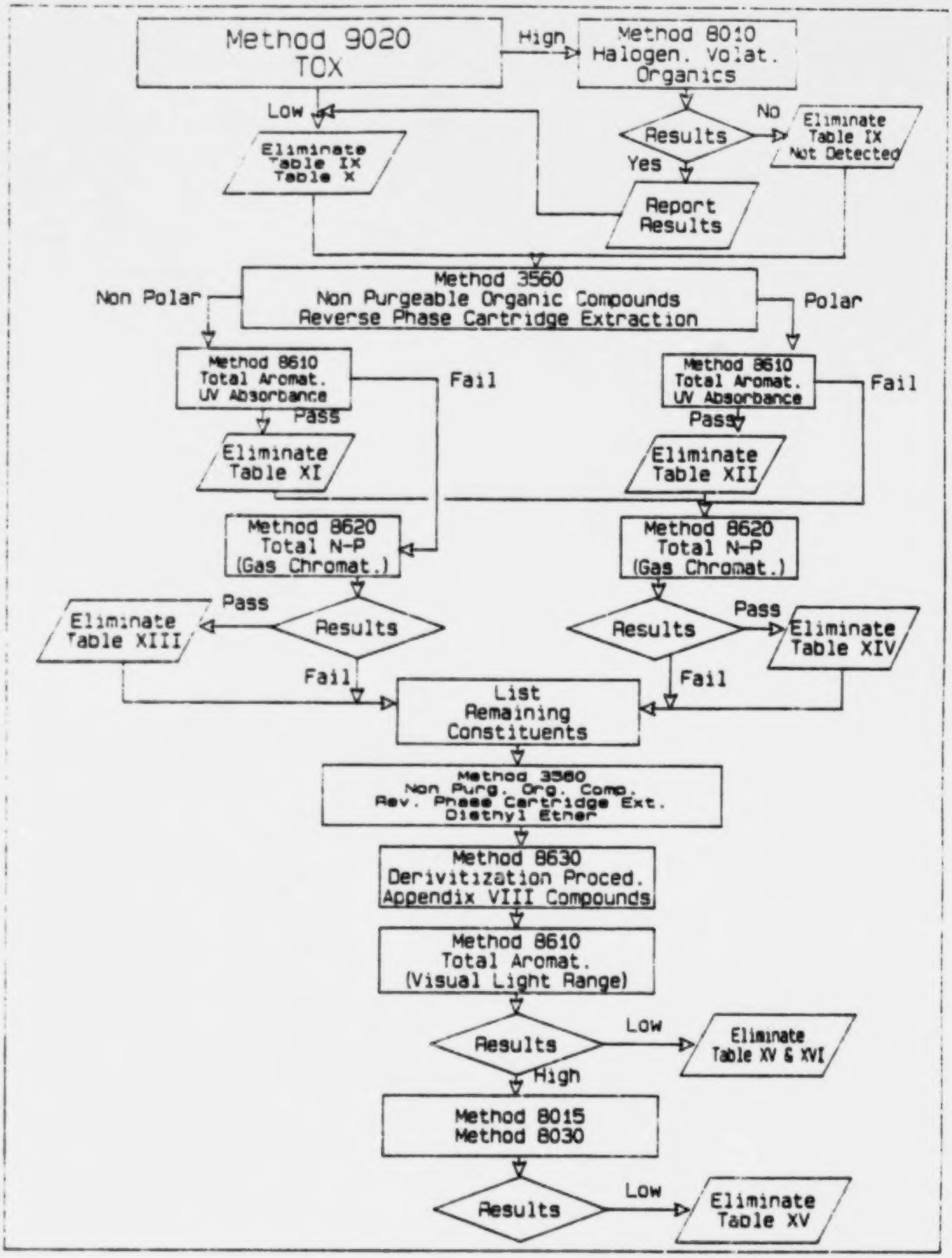
Method 9020
TOX
High
Method 8010
Halogen. Volat.
Organics
Low
Results
No
Eliminate
Table IX
Not Detected
Eliminate
Table IX
Table X
Yes
Report
Results
Method 3560
Non Purgeable Organic Compounds
Reverse Phase Cartridge Extraction
Non Polar
Polar
Method 8610
Total Aromat.
UV Absorbance
Fail
Pass
Eliminate
Table XI
Method 8610
Total Aromat.
UV Absorbance
Fail
Pass
Eliminate
Table XII
Method 8620
Total N-P
(Gas Chromat.)
Method 8620
Total N-P
(Gas Chromat.)
Pass
Eliminate
Table XIII
Results
Fail
Results
Pass
Eliminate
Table XIV
Fail
List
Remaining
Constituents
Method 3560
Non Purg. Org. Comp.
Rev. Phase Cartridge Ext.
Diethyl Ether
Method 8630
Derivitization Proced.
Appendix VIII Compounds
Method 8610
Total Aromat.
(Visual Light Range)
Results
Low
Eliminate
Table XV & XVI
High
Method 8015
Method 8030
Results
Low
Eliminate
Table XV

Figure 1. Schematic of the Hierarchical Analysis Protocol (HAP).

Table 4

Volatile Organic Compounds Determined by the Pentane Extraction Procedure

Compound Name	NPDES No.	Detection Limit, ug/L
Acrolein	01V	10
Acrylonitrile	02V	10
Benzene	03V	10
Carbon tetrachloride	06V	10
Chlorobenzene	07V	10
1,2-dichloroethane	15V	10
1,1,1-trichloroethane	27V	10
1,1-dichloroethane	14V	10
1,1,2-trichloroethane	28V	10
1,1,2,2-tetrachloroethane	23V	10
Chloroethane	09V	10
Bis(chloromethyl) ether	04V	10
2-chloroethyl vinyl ether	10V	10
Chloroform	11V	1
1,2-dichlorobenzene	25	10
1,3-dichlorobenzene	25B	10
1,4-dichlorobenzene	27B	10
trans-1,2-dichloroethylene	26V	10
1,1-dichloropropane	17V	10
1,3-dichloropropylene	18V	10
Ethyl benzene	19V	10
Methylene chloride	22V	10
Methyl chloride	21V	10
Bromoform	05V	1
Dichlorobromomethane	12V	1
Trichlorofluoromethane	30V	10
Chlorodibromomethane	08V	1
Tetrachloroethylene	24V	1
Toluene	25V	10
Trichloroethylene	29V	1
Vinyl chloride	31V	10

Table 5

Semi-volatile Organic Constituents Determined by Method 1625

Compound	NPDES Code	Detection Limit[a]
2-Chlorophenol	1A	10
2,4-Dichlorophenol	2A	10
2,4-Dimethylphenol	3A	10
4,6-Dinitro-O-Cresol	4A	10
2,4-Dinotrophenol	5A	10
2-Nitrophenol	6A	10
4-Nitrophenol	7A	10
P-Chloro-M-Cresol	8A	10
Pentachlorophenol	9A	10
Phenol	10A	10
2,4,6-Trichlorophenol	11A	10
Acenaphthene	1B	10
Acenaphtylene	2B	10
Anthracene	3B	10
Benzidine	4B	10
Benzo(a)anthracene	5B	10
Benzo(a)pyrene	6B	10
3,4-Benzofluoranthene	7B	10
Benzo(ghi)Perylene	8B	10
Benzo(k)fluoranthene	9B	10
Bis(2-Chloroethoxy) Methane	10B	b
Bis(2-Chloroisopropyl) Ether	11B	b
Bis(2-Chloroisopropyl) Ether	12B	b
Bis(2-Ethylhexyl) Phthalate	13B	10
4-Bromophenyl Phenyl	14B	b
Butyl Benzyl Phthalate	15B	10
2-Chloronaphthalene	16B	10
4-Chlorophenyl Phenyl Ether	17B	b
Chrysene	18B	10
Dibenzo(a,h)Anthracene	19B	10
1,2-Dichlorobenzene	20B	10
1,3-Dichlorobenzene	21B	10
1,4-Dichlorobenzene	22B	10
3,3'-Dichlorobenzidine	23B	b
Diethyl Phthalate	24B	10
Dimethyl Phthalate	25B	10
Di-N-Butyl Phthalate	26B	10
2,4-Dinitrotoluene	27B	10
2,6-Dinitrotoluene	28B	10
Di-N-Octyl Phthalate	29B	10
1,2-Diphenylhydrazine (as Azobenzene)	30B	b
Fluoranthene	31B	10
Fluorene	32B	10
Hexachlorobenzene	33B	10
Hexachlorobutadiene	34B	10
Hexachlorocyclopentadiene	35B	10
Hexachloroethane	36B	10
Indeno(1,2,3-cd)pyrene	37B	10
Isophorene	38B	
Naphthalene	39B	10
Nitrobenzene	40B	10
N-Nitrosodimethylamine	41B	b
N-Nitrosodi-N-Propylamine	42B	b
N-Nitrosodiphenylamine	43B	b
Phenanthrene	44B	10
Pyrene	45B	10
1,2,4-Trichlorobenzene	46B	10
Aldrine	1P	10
-BHC	2P	10
-BHC	3P	10
-BHC	4P	10
-BHC	5P	10
Chlordane	6P	b
4,4'-DDT	7P	10
4,4'-DOE	8P	10
4,4'-DDD	9P	10
Dieldrin	10P	10
-Endosulfan	11P	10
-Endosulfan	12P	10
Endosulfan Sulfate	13P	10
Endrin	14P	10
Endrin Aldehyde	15P	b
Heptachlor	16P	10
Heptachlor Epoxide	17P	10
PCB-1242	18P	b
PCB-1254	19P	b
PCB-1221	20P	b
PCB-1232	21P	b
PCB-1248	22P	b
PCB-1260	23P	b
PCB-1016	24P	b
Toxaphene	25P	b

---

[a] Units are ppb based on original sample.

b - No detection limit has been determined.

Table 6

Listing of Classes of Organic Compounds in Various Tables Related to the 8600 Methods

Table 3A:	Volatile Halogenated Organics
Table 3B:	Semi-Volatile Halogenated Organics
Table 4 :	Non-Polar UV Compounds
Table 5 :	UV Active, Semi Volatile Polar Organics
Table 6 :	N/P Containing, UV Active Non-Polar Organics
Table 7 :	N/P Containing, UV Active Polar Organics
Table 8 :	Volatiles Derivatized by Method 8630
Table 9 :	Non-Volatiles Derivatized by Method 8630

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It should be noted here that the Sheffield and Barnwell samples were treated in a slightly different manner. Initial intent was to follow the HAP as outlined in Figure 1 for the Sheffield samples. However, as the HAP progressed it was evident that the Sheffield samples would fail many of the screening procedures. Upon failing a screening test one would hope to follow with a method that would identify and possibly quantitate the constituents responsible for the failure. However such qualitative and quantitative procedures are not an inherent part of the HAP. Thus only after about two weeks were the Sheffield samples subjected to analysis by the pentane extraction method for volatiles and Method 1625 for semi volatiles. In the case of the Barnwell samples these methods with their inherent qualitative and quantitative capabilities were applied immediately.

2.3 QUALITY ASSURANCE MEASURES

In order to provide a check of laboratory accuracy, duplicate samples were obtained from two wells at each site, spiked with an EPA quality control material, and analyzed. The wells selected for duplicate sampling and analyses were the background well, a sample from which was spiked with a low concentration of standard, and the well suspected to be most contaminated. At the Sheffield site, the trench sump sample was spiked, and at the Barnwell site, a sample from a well adjacent to trenches was spiked. Recovery of the spikes in each case is reported in Section 3.

Quality assurance for the organic analytical procedures was essentially three-fold. For the HAP screen a "blind" standard was prepared and submitted for analysis. This "blind" standard contained parathion, fluoranthene, and trichlorophenol and would lead to "fails" in the screening procedure for the polar extract, (from Method 3560) when tested by Methods 8610 and 8620. In addition the nonpolar extract from Method 3560 should fail Method 8610. Thus this "blind" standard should cause Tables 4, 5, and 7, (listed in the EPA in the HAP) to not be eliminated by the screen. For the quantitative organic analyses two different sets of standards were spiked into the water samples in the laboratory. Before extraction known amounts of 2-fluorophenol, 2-fluoronaphthalene, and D10-phenanthrene were

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added to the water. These three compounds served as recovery standards for the extraction. After extraction and before final concentration D8-napthalene, D10-acenaphthalene, D10-Fluorene, D10-anthracene, D12-chrysene, and D12-Benzo(a)pyrene were added to serve as internal standards for the quantitation. This latter set of six deuterated standards were selected to ensure presence of an internal standard at various retention time intervals throughout the chromatogram during the gas chromatography/mass spectrometry analysis of the semi-volatile extract, (Method 1625).

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3.0 RESULTS AND DISCUSSION

Results of sampling and analytical activities at Sheffield, Illinois and Barnwell, South Carolina are presented in this section.

3.1 SHEFFIELD LOW LEVEL WASTE DISPOSAL SITE

The U.S. Ecology Low Level Waste Disposal Facility is located three miles southwest of the town of Sheffield, Illinois. The terrain in the vicinity is gently rolling. At the site, an average of 17 m (55 ft) of glacial deposits overlie Pennsylvanian age shale (Ref. 1).

3.1.1 Field Data and Description of Sampling Activities

On January 14-15, 1985, samples were obtained from Sheffield. Figure 2 shows the locations of wells sampled in this study. Well T-18 is a trench sump well, Well 523 is located very near disposal trenches, Wells 563 and 575 are both located in the offsite migration pathway (Ref. 1), and Well 574 is used as a background water quality well. Even though Well 574 is located downgradient from the site, it has not shown either tritium or organic contamination in previous monitoring activities. During bailing to purge the stagnant water from the well, Wells 523 and 563 were bailed dry. Well 523 yielded only enough water to perform the organic analyses. All the other wells yielded sufficient water to enable bailing at least three well volumes prior to sampling. Because previous monitoring data indicate elevated tritium content, water purged from well T-18 was collected in a 55 gallon drum and was poured back into the well after sampling was completed to prevent spread of contamination.

Table 7 includes field data recorded during the sampling trip. Water levels in wells, total depths, and well diameters were used to compute the volume of water in the well. Specific conductance and pH data were obtained on samples from two wells using equipment at the U.S. Ecology onsite lab facility. Temperature data recorded are not reliable ground water temperatures because very low atmospheric temperatures rapidly cooled the

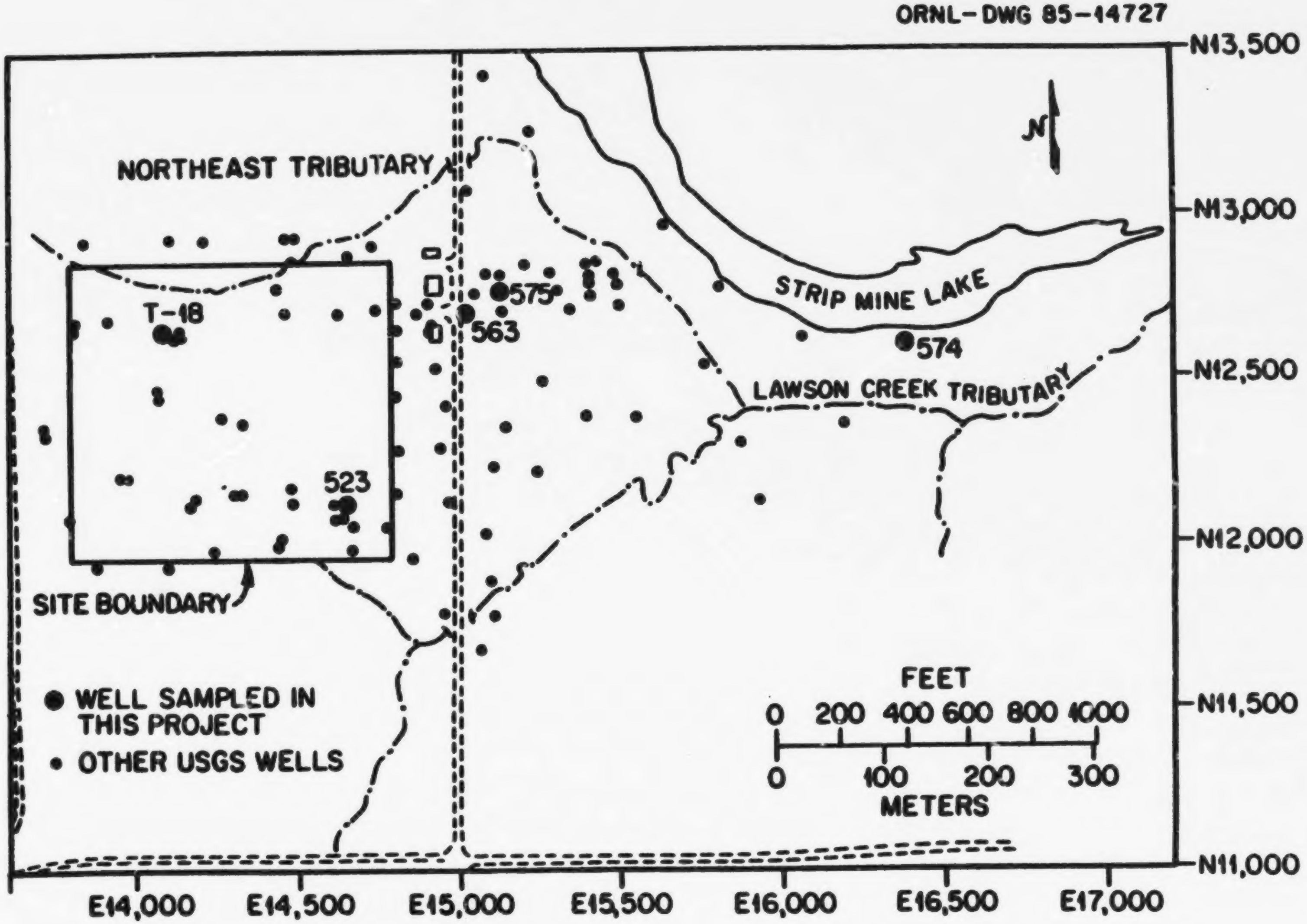
ORNL-DWG 85-14727
N13,500
N13,000
N12,500
N12,000
N11,500
N11,000
E14,000
E14,500
E15,000
E15,500
E16,000
E16,500
E17,000
N
NORTHEAST TRIBUTARY
STRIP MINE LAKE
LAWSON CREEK TRIBUTARY
SITE BOUNDARY
T-18
575
563
574
523
● WELL SAMPLED IN THIS PROJECT
• OTHER USGS WELLS
FEET
0 200 400 600 800 1000
0 100 200 300
METERS

Figure 2. Location of wells sampled at the Sheffield site.

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Table 7

Summary of Field Data Recorded During Sampling at Sheffield, Illinois

	Well Information					Physicochemical Data			
Well I.D. and Date Sampled	Depth to Water	Total Depth	Height of Water Col.	Well Diam.	Vol. of Water in Casing (gallon)	Bailed Volume (gallon)	Temperature (F°)	pH	Specific Conductance (μmho/cm)
Well 563 1/14/85	41.29'	46.92'	5.6'	4"	3.6	2.5	38.4	7.5	-
						5.2	38.4	6.45	840
						7.9	38.4	6.47	840
	After bailing 10.5 gallons the well bailed down to near dry - allowed to recover prior to sampling								
Well 575 1/14/85	32.66'	38.66'	6.0'	4"	3.9	2.6	38.5	6.45	860
						5.2	38.5	6.37	850
						7.9	38.4	6.13	850
						10.6	38.4	6.15	850
Well 574 1/15/85	9.88'	19.58'	9.7'	4"	6.3				
	Bailed 60 L 1/14/85 Bailed 20 L a.m. 1/15/85 prior to pulling samples								
Well 523 1/15/85	30.79'	33.5'	2.8'	5" 4" screen					
	Bailed approximately 1 gal a.m. 1/15/85 well was bailed dry Sampled for organics analyses only after recovery								
Well T-18 1/15/85	17.25'	22.42'	5.2'	6"	7.6				
	Bailed approximately 15 gallons prior to sampling								

Note: All bailers used were approximately 1L bailers.

samples. Conductance and pH data were not obtained from the other wells because of inaccessibility by vehicle due to snow, and all three wells were remote from the laboratory. Battery failure occurred rapidly in field equipment due to low temperature, precluding use of field meters at the well sites.

3.1.2 Laboratory Analytical Results

This section presents results of analyses obtained on the samples from Sheffield, Illinois. Parameters are reported in three groups: inorganic, radiological and organic parameters.

Inorganic Parameters

Table 8 includes the results of inorganic analyses on samples obtained from four wells. Single samples were obtained and analyzed from Wells 563 and 575, and duplicate samples were collected and analyzed from Wells 574 and T-18. Ground water obtained from Well 574 is presumed to represent the local background ground water quality. Dissolved constituents are predominated by calcium, sodium, magnesium, and bicarbonate with minor sulfate and chloride content. Trace metal concentrations are low. Concentrations of the major dissolved constituents in T-18 are more than twice the levels detected in the background well. Water quality in Wells 563 and 575 is intermediate between the water quality encountered in T-18 and the background condition.

The general trend observed for major dissolved constituents and several trace constituents is lowest in Well 574, slightly higher in Well 575, higher in Well 563, and highest in the Trench 18 well. Constituents which show this trend include bicarbonate, sulfate, chloride, calcium, magnesium, boron, cadmium, and nickel. Iron content is possibly related to well casing materials and is higher in the steel cased wells than in the PVC cased trench well. Potassium and sodium are highest in the trench well, lower in the background well, and lowest in Wells 563 and 575.

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Table 8

Results of Inorganic Analyses on Ground Water Samples from Sheffield, Illinois (1/14-15/85)

Parameter	Units of Measurement	Well 574	Well 574-1[a]	Well 575	Well 563	Trench 18	Trench 18-1[a]
		Metals measured by atomic absorption					
Ag	µg/ml	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
As	"	0.002	0.052[b]	0.005	<0.001	0.003	0.042[b]
Ba	"	0.30	0.22	0.52	0.22	0.33	0.37
Cd	"	0.0002	0.0005[b]	0.0002	0.0004	0.0007	0.0015[b]
Cr	"	0.002	0.019[b]	<0.002	<0.002	0.003	0.009[b]
Cu	"	0.011	0.01	0.004	0.005	0.020	0.01
Pb	"	<0.001	0.002	<0.001	<0.001	0.002	0.002
Ni	"	<0.005	<0.005	<0.005	0.011	0.028	0.046[b]
Se	"	<0.003	0.007[b]	<0.003	<0.003	<0.003	0.008[b]
Sb	"	<0.004	<0.004	<0.004	<0.004	0.007	0.008
Hg	"	<0.00005	0.0004[b]	<0.00005	<0.00005	<0.00005	0.0014[b]
		Anions					
Br	"	<5	<5	<5	<5	<5	<5
Cl	"	13	4	4	19	32	23
F	"	<1	<1	<1	<1	<1	<1
CO_3	"	0.0	0.0	0.0	0.0	0.0	0.0
HCO_3	"	436	440	563	562	1173	1161
NO_2	"	0.3	0.4	0.3	0.3	1.2	0.9
NO_3	"	<5	<5	<5	<5	<5	<5
SO_4	"	84	89	295	171	380	390
Cyanide	"	<0.0014	<0.002	<0.0014	<0.0014	0.0016	0.0032
Sulfide	"	<0.1	<0.1	<0.1	<0.1	c	<0.1

Table 8 (Continued)

Parameter	Units of Measurement	Well 574	Well 574-1[a]	Well 575	Well 563	Trench 18	Trench 18-1[a]
Cations measured by inductive coupled plasma							
Al	µg/ml	<0.2	<0.2	<0.2	<0.2	0.44	0.34
B	"	0.59	0.74	0.32	2.1	27	27
Be	"	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ca	"	89	88	160	170	240	240
Co	"	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fe	"	0.44	0.4	0.65	0.22	0.28	0.22
Ga	"	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hf	"	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
K	"	2.8	2.9	0.8	0.9	120	120
Li	"	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mg	"	47	46	70	69	120	120
Mn	"	0.17	0.17	1.9	1.1	1.1	1.1
Mo	"	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Na	"	53	52	18	17	190	200
P	"	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Si	"	9.9	9.7	16	14	11	11
Sr	"	0.7	0.68	0.18	0.19	0.89	0.89
Ti	"	<0.02	<0.02	<0.02	<0.02	0.025	0.022
V	"	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Zn	"	<0.02	<0.02	<0.02	0.073	0.17	0.18
Zr	"	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06

[a] Samples 574-1 and Trench 18-1 are duplicate sample spilts obtained for quality assurance purposes.

[b] Value reported from a spiked sample with incomplete spike recovery - reported value is a maximum concentration.

[c] Sample was accidentally lost during preparations for shipping.

Radiological Parameters

Radiological parameters analyzed on the Sheffield samples included gross alpha activity, gross beta activity, and tritium. Results of these analyses are presented in Table 9. Statistical counting uncertainty is expressed as the plus/minus range. Tritium was detected in Wells 575, 563, and in the trench sump well. Insufficient sample was available for analysis from Well 523. Tritium values obtained from these samples are similar to those reported by the Illinois Department of Nuclear Safety from samples obtained in July 1983. Some beta activity was detected in the samples obtained from the trench sump. No other significant beta activity was detected and no significant alpha activity was detected in any of the samples.

Tritium levels in Well T-18 (3.8E5 pCi/L), Well 563 (1.7E5 pCi/L), and Well 575 (1.5E5 pCi/L) are above the 2.0E4 pCi/L primary drinking water limit for tritium.

Organic Parameters

Total organic carbon (TOC) and total organic halides (TOX) analyses were performed on samples from all wells. Results of these analyses are presented in Table 10. TOC and TOX show, in general, the same relative concentration trend as tritium and major dissolved constituents previously discussed.

Table 11 shows the results obtained for the HAP screen of the Sheffield water samples. It is evident from these results that many classes of compounds were not eliminated. This is quite understandable because the requirements to pass Method 8610, (ultraviolet absorption) specify that the absorbance between 220 nm and 310 nm should not exceed 0.005 when measured relative to the upgradient sample. Many single constituents originally present at concentrations on the order of 1 ppb can give rise to absorbances of this magnitude. The results of the HAP for each of the Sheffield water samples can be summarized as follows:

Table 9

Results of Radiological Analyses Performed on Ground Water Samples from Sheffield, Illinois (1/14-15/85)

Parameter	Units of Measurement	Well 574	Well 574-1[a]	Well 575	Well 563	Trench 18	Trench 18-1[a]
Gross alpha	pCi/l	19±108	2.7±111	81±135	81±135	81±135	39±122
Gross beta	"	54±125	5.4±119	<108	13.5±127	1.3E3±2.4E2	1.2E3±2.4E2
Tritium	"	<810	<810	1.5E5±2.7E3	1.7E5±2.7E3	4.3E5±2.7E4	4.3E5±2.7E4

Table 10

Results of Total Organic Carbon and Total Organic Halides Analyses, Sheffield Water Samples (1/14-15/85)

Parameter	Unit of Measurement	Well 574	Well 574-1[a]	Well 575	Well 563	Trench 18	Trench 18-1[a]	Well 523
TOC	µg/ml	2.8	1.9	2.9	10	48	43	40
TOX	µg/l	3,950	b	3,600	140	11,000	2,250	5,450

[a] Samples 574-1 and Trench 18-a are duplicate sample splits obtained in the field for Quality Assurance purposes.

[b] Sample bottle broke after receipt at lab while warming.

Table 11

Summary Showing Which Tables of Organic Compourds May Be Present in Sheffield, Illinois Water Samples (1/14-15/85)

Sample	Tables of Organic Compound							
	3	3B	4	5	6	7	8	9
Well 575 (1636)	X	X	X	-	-	-	X	X
Well 563 (1638)	X	X	X	-	-	-	X	X
Trench 18 (1639)	X	X	X	X	-	X	X	X
Trench 18 (1640)	X	X	X	X	-	X	X	X
Well 523 (1643)	X	X	X	-	-	-	X	X
Well 574 (1637/1641)	-	X	X	-	-	-	-	X

(X)Indicates a table that could not be eliminated.

(-)Indicates a table that could be eliminated.

Well 575. This sample has relatively low organic content with the bulk of this organic content being volatile. There appear to be two major volatile halogenated constituents (Method 8010) and several additional non-halogenated volatile constituents.

Well 563. The semi-volatile and non-volatile organic content appears to be low; however, the organic volatiles content (both halogenated and non-halogenated) appears to be quite high with the chromatographic profiles from Methods 8010, 8015, and 8030 all showing several major chromatographic peaks

Trench 18. Water samples from this trench showed very high organic content including both volatile and semi-volatile compounds. In the halogenated volatiles profile (Method 8010), there are at least eight major components. In like manner, the ultraviolet spectrum of the reversed phase extract (Method 8610) showed the highest intensity of any sample.

Well 523. This well showed fairly high organic content with both the volatile methods (8010, 8015, and 8030) and general method (8610) showing positives.

Well 574. This was the upgradient sample. Thus, only the volatile results can be compared with the other samples; but in all cases (Methods 8010, 8015, and 8030), this sample showed the lowest response for organic volatile compounds.

Because each of these samples failed one or more of the HAP screening tests, the samples were analyzed for both volatiles and semi-volatiles. The pentane extraction method along with Methods 8010, 8015, and 8030 were used for volatiles and Method 1625 was used for semi-volatiles. A number of volatile and semi-volatile organic compounds were tentatively identified in gas chromatograms obtained after completion of the EPA Method 8600 analysis (Appendix B). The accuracy of reported concentrations is questionable because the samples had aged considerably prior to analysis and the analyzed samples were aliquots from bulk samples rather than from valid volatile sample vials. The data in Table 12 represents an estimate based on chromatographic area without regard to individual calibrations. However, this estimation should reflect the relative amounts of volatiles in the Sheffield Samples with Trench 18>Well 523>Well 563>Well 575>Well 574. For the semi volatile organic constituents EPA Method 1625 was followed. Here the sample was prepared by solvent extraction and the analysis was carried out by Gas Chromatography with mass spectrometry detection. The method is

Table 12

Estimate of Volatiles in Sheffield Water Samples (1/14-15/85)

Sample	Estimated Concentration, ppb
Well 575	200
Well 574	170
Well 563	500
Trench 18	1800
Well 523	1450

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designed to identify and quantitate the compounds listed in Table 13, (except those compounds listed under "Other Compounds Detected". As shown in Table 13 only di-N-butylphthalate and several "other compounds" were detected in these samples. It should be pointed out that phthalates are common industrial chemicals and in some situations are almost ubiquitous. Thus the content of semi volatile organic compounds in these waters does not appear to be significant.

3.1.3 Quality Assurance Assessment - Sheffield Analytical Program

Measures taken to quantify the analytical accuracy of this study included analysis of an EPA quality control check sample as a blind control, spiking two duplicate sample sets with the same EPA material, and analysis of two internally prepared organic standard samples.

Table 14 presents EPA data on the quality control material used including average concentrations, percent error at the 95% (2σ) confidence interval, the value obtained by ORNL for the material, and the percent deviation of the ORNL value from the EPA average. The ORNL determinations are well within the 95% confidence interval for all elements except Hg. Analysis of other EPA standards for lower concentrations of Hg were accurate within 4%, therefore the reliability of the EPA quality control material for Hg is in question.

Table 15 presents results of analyses of the two ground water samples which were spiked with the inorganic control. This table shows the analytical recovery of the EPA QC material spiked into natural water samples with a relatively complex chemical composition. In such a situation, the potential exists for chemical effects which lead to incomplete spike recovery or chemical interference in analyses. The spiked concentrations were above the regulatory limits for the EPA toxic metals and for some analyses, dilutions were required to bring the sample concentrations into the proper range for analysis. The process of sample dilution also introduces error in the final analytical volume.

The table includes the value determined on the unspiked duplicate sample and the spike concentration added. For elements which were detected above the detections limit, the detected value plus spike concentration

Table 13

Semi-volatile Organic Constituents in the Sheffield, Illinois Samples (1/14-15/85)

Compound	NPDES Code	Detection Limit[a]	Well 575	563	523	574	Trench 18
2-Chlorophenol	1A	10					
2,4-Dichlorophenol	2A	10					
2,4-Dimethylphenol	3A	10					
4,6-Dinitro-O-Cresol	4A	10					
2,4-Dinotrophenol	5A	10					
2-Nitrophenol	6A	10					
4-Nitrophenol	7A	10					
P-Chloro-M-Cresol	8A	10					
Pentachlorophenol	9A	10					
Phenol	10A	10					
2,4,6-Trichlorophenol	11A	10					
Acenaphthene	1B	10					
Acenaphtylene	2B	10					
Anthracene	3B	10					
Benzidine	4B	10					
Benzo(a)anthracene	5B	10					
Benzo(a)pyrene	6B	10					
3,4-Benzofluoranthene	7B	10					
Benzo(ghi)Perylene	8B	10					
Benzo(k)fluoranthene	9B	10					
Bis(2-Chloroethoxy) Methane	10B	b					
Bis(2-Chloroisopropyl) Ether	11B	b					
Bis(2-Chloroisopropyl) Ether	12B	b					
Bis (2-Ethylhexyl) Phthalate	13B	10					
4-Bromophenyl Phenyl	14B	b					
Butyl Benzyl Phthalate	15B	10					
2-Chloronaphthalene	16B	10					
4-Chlorophenyl Phenyl Ether	17B	b					
Chrysene	18B	10					
Dibenzo(a,h)Anthracene	19B	10					
1,2-Dichlorobenzene	20B	10					
1,3-Dichlorobenzene	21B	10					
1,4-Dichlorobenzene	22B	10					
3,3'-Dichlorobenzidine	23B	b					
Diethyl Phthalate	24B	10					
Dimethyl Phthalate	25B	10					
Di-N-Butyl Phthalate	26B	10	>10	>10	>10	>10	10
2,4-Dinitrotoluene	27B	10					
2,6-Dinitrotoluene	28B	10					
Di-N-Octyl Phthalate	29B	10					
1,2-Diphenylhydrazine (as Azobenzene)	30B	b					
Fluoranthene	31B	10					
Fluorene	32B	10					
Hexachlorobenzene	33B	10					
Hexachlorobutadiene	34B	10					

Table 13 (Continued)

Compound	NPDES Code	Detection Limit[a]	Well				Trench
			575	563	523	574	18
Hexachlorocyclopentadiene	35B	10					
Hexachloroethane	36B	10					
Indeno(1,2,3-cd)pyrene	37B	10					
Isophorone	38B						
Naphthalene	39B	10					
Nitrobenzene	40B	10					
N-Nitrosodimethylamine	41B	b					
N-Nitrosodi-N-Propylamine	42B	b					
N-Nitrosodiphenylamine	43B	b					
Phenanthrene	44B	10					
Pyrene	45B	10					
1,2,4-Trichlorobenzene	46B	10					
Aldrin	1P	10					
-BHC	2P	10					
-BHC	3P	10					
-BHC	4P	10					
-BHC	5P	10					
Chlordane	6P	b					
4,4'-DDT	7P	10					
4,4'-DDE	8P	10					
4,4'-DDD	9P	10					
Dieldrin	10P	10					
-Endosulfan	11P	10					
-Endosulfan	12P	10					
Endosulfan Sulfate	13P	10					
Endrin	14P	10					
Endrin Aldehyde	15P	b					
Heptachlor	16P	10					
Heptachlor Epoxide	17P	10					
PCB-1242	18P	b					
PCB-1254	19P	b					
PCB-1221	20P	b					
PCB-1232	21P	b					
PCB-1248	22P	b					
PCB-1260	23P	b					
PCB-1016	24P	b					
Toxaphene	25P	b					
Other Compounds Detected							
Cyclohexene			>10	>10	>10	>10	50
Dioxane			>10	>10	>10	>10	50
Glycol w/a nitrogen function							D
Hydrocarbon w/cl and/or O							D

[a]Units are ppb based on original sample.
No entry means that compound was not detected.
b - No detection limit has been determined.
D - Compound detected at concentration less than 10 ppb.

Table 14

Analytical Results and Deviation for EPA Inorganic Control Material Sheffield Analytical Program

Element	EPA Average Concentration µg/ml	95% Confidence Interval	ORNL Concentration µg/ml	% Deviation from EPA Average
Al	0.745	17%	0.86	+15
As	0.234	22%	0.23	-2
Be	0.232	11%	0.24	+2
Cd	0.0369	16%	0.037	+0.3
Cr	0.258	19%	0.25	-3
Co	0.259	12%	0.26	-0.4
Cu	0.335	10%	0.36	+7
Fe	0.789	12%	0.79	-0.1
Pb	0.430	14%	0.41	-5
Mn	0.346	12%	0.35	+1
Hg	0.00850	30%	0.005	-41
Ni	0.206	14%	0.20	-3
Se	0.0469	33%	0.037	-21
V	0.864	16%	0.84	-3
Zn	0.415	8%	0.44	+6

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Table 15

Results of Inorganic Quality Control Analyses - Sheffield Analytical Program
Concentrations in μg/ml

	BACKGROUND WELL					TRENCH SUMP WELL				
Element	Unspiked Sample Concentration	Spike Concentration		Spiked Sample Concentration	Maximum % Error	Unspiked Sample Concentration	Spike Concentration		Spiked Sample Concentration	Maximum % Error
		EXPECTED RANGE					EXPECTED RANGE			
Al	<0.2	0.373	<0.573	0.59	+3% - +58%	<0.2	0.373	<0.573	0.48	-16% - +29%
As	0.002	0.117	0.119	0.17	+43%	0.002	0.117	0.119	0.16	+35%
Be	<0.001	0.116	<0.117	0.14	+20%	<0.001	0.116	<0.117	0.12	+3% - +4%
Cd	<0.009	0.0185	<0.0275	0.022	-20% - +19%	<0.009	0.0185	<0.0275	0.021	-24% - +14%
Cr	0.031	0.129	0.16	0.18	+13%	0.031	0.129	0.16	0.16	0%
Co	<0.02	0.130	<0.15	0.15	0 - +15%	<0.02	0.130	<0.15	0.13	-13% - 0%
Cu	<0.02	0.168	<0.188	0.2	+6% - +20%	0.023	0.168	0.191	0.2	+5%
Fe	1.4	0.395	1.795	1.8	0.3%	<0.03	0.395	<0.425	0.42	-1% - +6%
Pb	<0.2	0.215	<0.415	0.27	-35% - +26%	<0.02	0.215	<0.235	0.25	-16% - +15%
Mn	0.17	0.173	0.343	0.36	+5%	1.1	0.173	1.273	1.2	-6%
Hg	<0.00005	0.0043	<0.0044	0.004	-10% - -7%	<0.00005	0.0043	<0.0044	0.003	-32% - -30%
Ni	<0.06	0.103	<0.163	0.11	-33% - +7%	<0.06	0.103	<0.163	0.13	-20% - +13%
Se	<0.003	0.0235	<0.0265	0.021	-21% - -11%	<0.003	0.0235	<0.0265	0.020	-25% - -15%
V	<0.03	0.432	<0.462	0.5	+8% - +16%	<0.03	0.432	<0.462	0.44	-5% - +2%
Zn	0.21	0.208	0.418	0.3	-28%	0.36	0.208	0.568	0.49	-14%

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should be detected in the spiked sample. For elements which were reported below detection limit in the unspiked sample, a range of expected concentration is computed assuming that the true value lies between 0 and the detection limit. The expected range of concentrations in the spiked sample then ranges from the spike concentration (if the true value is 0) to the spike plus detection limit (if the true value is equal to the detection limit). The maximum percent error is then expressed as a single value for those elements detected above detection limits (for example As, Cr, Mn, Zn) and as a range of possible maximum error for elements present at less than the detection limit.

The data in Table 15 show that for most elements, recovery of the spike was good. Recovery of arsenic was consistently high and recovery of mercury was low. EPA standard materials were also analyzed concurrently with these samples and analytical results obtained on those samples were within 5% for arsenic and 4% for mercury indicating that the analytical accuracy on the unspiked samples is very good.

The maximum percent error determined from the spike is not unusual when you are dealing with such low concentrations and does not affect the interpretation of results for the EPA toxic metals because the detected values are at least an order of magnitude below the regulatory limits (Section 3.1.4).

The set of water samples from the Sheffield, Illinois site also contained two blank water samples which had been spiked with parathion, trichlorophenol, and fluoranthene. For both cases compounds in Tables 4, 5, and 7 failed to pass the HAP screen, which is what one would expect for pure water containing only these three organic constituents. It should be noted here however that the screening procedure to eliminate Tables 8 and 9 did not appear to be very definitive. This screening procedure consists of sample isolation by Method 3560, derivitization by Method 8630, and screening evaluation by Method 8610. In all cases applying this sequence of methods resulted in yellow solutions with fairly high absorbances. Thus when Method 3560 was applied to these preparations the relative absorbances appeared to be more a function of the sample preparation rather than of the original organic content of the samples. Because two high absorbance values were being compared, this screening test appears to be of little value. It is simply a fortuitous event if the upgradient sample has a lower absorbance than a contaminated sample because this sample treatment process contributes the bulk of the absorbance to a given sample. Thus this portion of the HAP screen may require extensive modification.

The HAP approach was also assessed by duplicate samples. The original set of samples contained two samples from Trench 18. The polar and nonpolar portions of these samples were isolated and screened by Methods 3560 and 8610, respectively. The total integrated spectral areas for both the polar and nonpolar fractions were 0.76 absorbance-nm and 0.69 absorbance-nm. Thus the sample recovery as measured by total ultraviolet absorbance, agreed within about 10% between the two samples from Well T-18.

3.1.4 Comparison of Analytical Results to Ground Water Protection Standards

The analytical results obtained at the Sheffield site are discussed in comparison to ground water protection requirements developed by the U.S. EPA in the Resource Conservation and Recovery Act. The RCRA ground water protection standards for eight heavy metals and for pesticides are based on the National Interior Primary Drinking Water Regulation [(NIPDWR) (40 CFR 141)] established under the Clean Water Act. Primary drinking water standards also exist for certain radiological constituents including tritium, gross alpha, and a maximum annual dose from beta and gamma emitting radionuclides. The primary drinking water standards are tabulated in Appendix A.

The EPA regulations regarding organic contamination at hazardous waste disposal sites include defining a compliance boundary around a disposal facility or unit and comparing upgradient and downgradient concentrations of listed organic constituents (40 CFR 260). Detection of listed organic constituents in the downgradient wells at levels exceeding background indicates failure of the facility to adequately contain those materials.

The low level radioactive waste disposal site lies to the east of and downgradient from a chemical waste disposal site. Interference in monitoring at the LLW site by contaminant migration from the chemical waste

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disposal site has not been evaluated, however the potential for such interference appears to exist. The chemical disposal site could be a source of inorganic and organic contaminants.

The results of analyses performed in this reconnaissance study of the Sheffield site show that heavy metal concentrations were at least one order of magnitude below the NIPDWR in all samples analyzed. Tritium concentrations were found to exceed the NIPDWR by approximately an order of magnitude in the trench well sampled and in Wells 563 and 575, located in a documented migration pathway (Ref. 1). Gross alpha and beta results indicate no migration of alpha or beta emitting radionuclides to the wells sampled with the exception that the Trench 18 samples contained approximately 50 pCi/L beta activity.

3.2 BARNWELL LOW LEVEL WASTE DISPOSAL SITE

The Chem Nuclear Low-Level Waste Disposal Facility is located five miles west of the town of Barnwell, South Carolina. The terrain is nearly flat and the site is underlain by a thick sequence of marine sedimentary deposits of Miocene age and older (Ref. 4).

3.2.1 Field Data and Description of Sampling Activities

On May 14, 1985, samples were obtained from the Barnwell site. Figure 3 shows the locations of the wells sampled. Wells WM-0039, WM-0035, and WM-0074, are located near low level waste disposal trenches. Well WB-802 is an upgradient background well. Well WB-102 is located at the downgradient perimeter fence of the disposal area.

Field data recorded during the sampling activities are presented in Table 16. Water levels in wells, total depths, and well diameters were used to compute the volume of water in the well. Specific conductance and pH data were recorded during bailing of each well and are reported in Table 16. Variation in pH and conductance occurred during well purging; however, the variations were typically small. Well WM-0035 contained the least volume of water of any of the wells sampled. This well had partially silted in,

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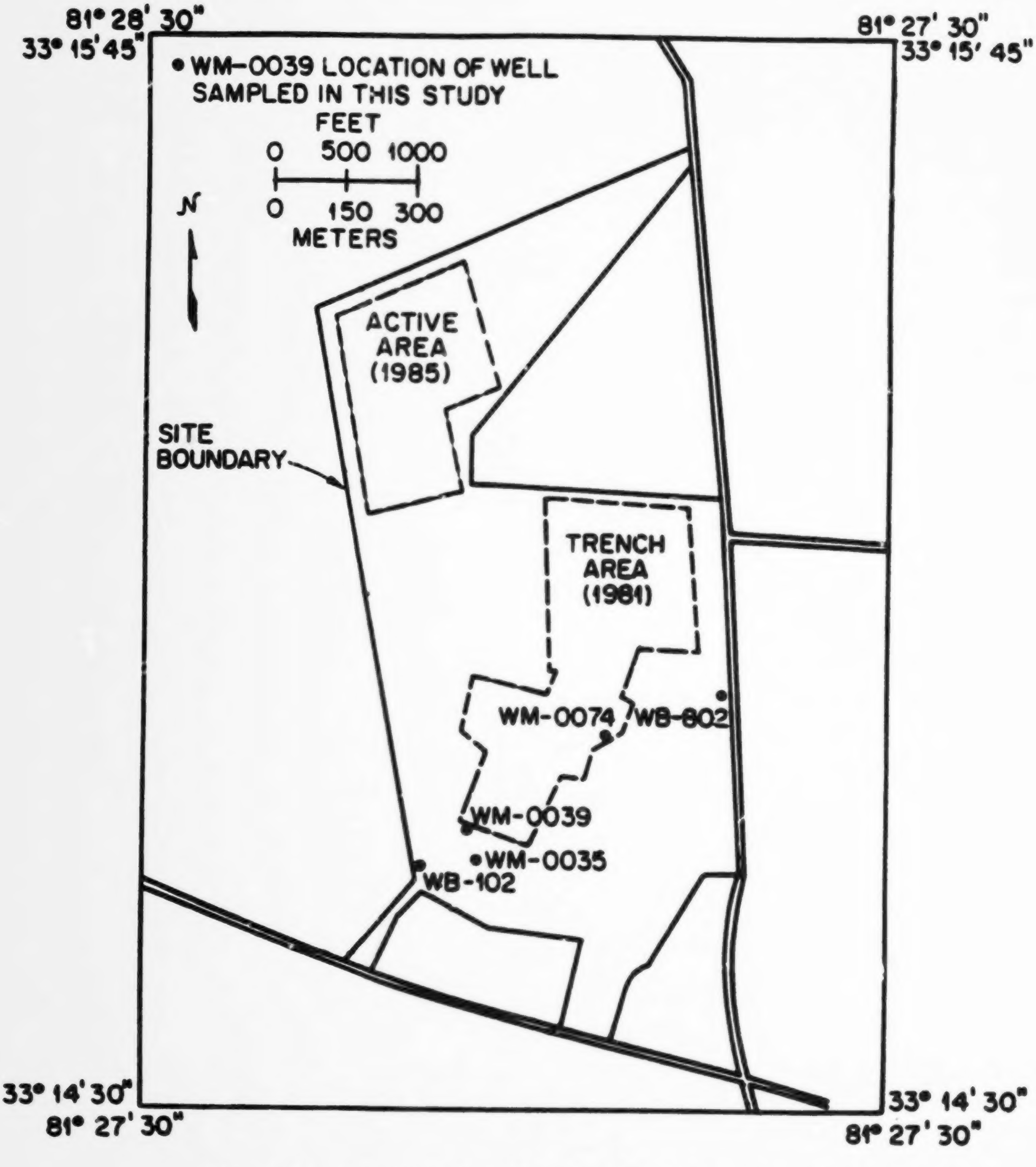
81° 28' 30"
33° 15'45"
81° 27' 30"
33° 15' 45"
• WM-0039 LOCATION OF WELL SAMPLED IN THIS STUDY
FEET
0 500 1000
0 150 300
METERS
N
ACTIVE AREA (1985)
SITE BOUNDARY
TRENCH AREA (1981)
WM-0074
WB-802
WM-0039
WM-0035
WB-102
33° 14'30"
81° 27' 30"
33° 14' 30"
81° 27' 30"

Figure 3. Location of wells sampled at the Barnwell site.

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Table 16

Summary of Field Data Recorded During Sampling at Barnwell, S.C. (5/14/85)

Well Information						Physicochemical Data					
Well I.D.	Depth to Water	Total Depth	Height of Water Col.	Well Diam.	Vol. of Water in Casing (gallon)	Bailed Volume (gallon)	pH	Specific Conductance (μmho/cm)	Bailed Volume (Continued)	pH (Continued)	Specific Conductance (Continued)
Well WM-0039	43.7'	64.4'	20.7'	10' x 2" screen 4"d casing	8.6	First bail	5.9	21	20	6.1	24
						15	6.1	25	End of sampling	6.1	25
						18	6.1	24			
Well WM-0035	41.2'	45.6'	4.4'	0-40'=4" 40-45.6'=2"	0.70	First bail	5.6	38	2	5.6	19
						1	5.5	19	3	6.0	
Well WB-102	36.8'	46.9'	10.1'	1.9"	1.5	First bail	5.0	41	7	5.1	40
						1	5.1	37	Middle of sampling	5.1	39
						2	5.0	39			
						3	5.0	39	End of sampling	5.1	39
						5	5.0	41			
						6	5.1	41			
Well WM-0074	49.6'	65.0'	15.4'	1.9"	2.3	First bail	5.9	28	5	6.3	37
						1	5.9	28	6	6.2	38
						2	6.0	35	7	6.4	38
						3	6.2	38	8	6.3	38
						4	6.2	35			
Well WB-802	41.0'	61.1'	20.1'	1.9"	3.0	First bail	5.5	26	6	5.6	24
						1	5.4	26	7	5.4	26
						2	5.4	28	8	5.6	26
						3	5.4	29	9	5.6	26
						4	5.4	29	End of sampling	5.4	30
						5	5.5	28			

yielded very silty sample water, and required over two hours to sample because of relatively slow recharge and recovery time. All the other sampled wells yielded sufficient water to enable continuous bailing to purge wells and obtain the necessary sample volumes.

3.2.2 Laboratory Analytical Results

This section presents the results of analyses on the samples from Barnwell, SC. Parameters are reported in three groups: inorganic, radiological, and organic.

Inorganic Parameters

Results of inorganic analyses performed on samples from the Barnwell site are presented in Table 17. The ground water from all wells is low in dissolved constituents. Metals classified by the EPA as toxic are present in low parts per billion concentrations. Anionic constituents are also low, and minor sulfide concentrations were detected. The major dissolved constituents are sodium, calcium, silicon, nitrate and bicarbonate. Silicon concentrations are fairly uniform, and calcium and sodium concentrations vary between the wells.

Wells WM-0035 and WM-0074 have slightly higher concentrations of several constituents relative to the other wells. Elements which are slightly elevated in these wells include Cd, Cu, Pb, Fe, and sulfide. The background well has a slightly elevated Zn content relative to most of the other wells, with the exception of Well WM-0039. Nitrate values approach the 10 ppm drinking water limit in the background well and exceed the limit at the downgradient well; however, nitrate values are low from the wells located near the disposal trenches.

Radiological Parameters

Radiological analyses performed on the Barnwell samples included measurement of gross alpha activity, gross beta activity, tritium, and

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Table 17

Results of Inorganic Analyses on Ground Water Samples from Barnwell, South Carolina (5/14/85)

Parameter	Units of Measurement	Well WB-802	Well WB-802-1[a]	Well WB-102	Well WM-0035	Well WM-0074	Well WM-0039	Well WM-0039-1[a]
				Metals measured by atomic absorption				
Ag	µg/ml	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.0002
As	"	<0.001	b	<0.001	<0.001	<0.001	<0.001	<0.056[c]
Ba	"	<0.02	<0.02	<0.02	<0.02	<0.02	0.24	0.072
Cd	"	0.004	0.003	0.002	0.005	0.003	0.003	<0.0081[c]
Cr	"	<0.001	b	<0.001	<0.001	0.001	0.001	<0.022[c]
Cu	"	0.003	<0.01[c]	0.002	0.014	0.001	0.001	<0.075[c]
Pb	"	0.001	b	0.001	0.005	0.006	0.001	<0.01[c]
Ni	"	<0.005	<0.016[c]	<0.005	<0.005	<0.005	<0.005	<0.014[c]
Se	"	<0.001	b	<0.001	<0.001	<0.001	<0.001	0.0011[c]
Sb	"	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Hg	"	<0.00005	b	<0.00005	<0.00005	<0.00005	<0.00005	b
				Anions				
Br	"	<5	<5	<5	<5	<5	<5	<5
Cl	"	3	3	3	2	3	2	2
F	"	<1	<1	<1	<1	<1	<1	<1
CO_3	"	0	0	0	0	0	0	0
HCO_3	"	3	0	2	3	13	0	5
NO_2	"	<5	<5	<5	<5	<5	<5	<5
NO_3	"	9	9	16	<5	6	<5	<5
SO_4	"	<5	<5	<5	<5	<5	<5	<5
Cyanide	"	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Sulfide	"	<0.01	<0.01	0.01	0.03	0.07	0.02	<0.01

Table 17 (Continued)

Parameter	Units of Measurement	Well WB-802	Well WB-802-1[a]	Well WB-102	Well WM-0035	Well WM-0074	Well WM-0039	Well WM-0039-1[a]
				Cations measured by inductive coupled plasma				
Al	µg/ml	<0.2	b	<0.2	<0.2	<0.2	<0.2	b
B	"	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Be	"	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	0.008[c]
Ca	"	1.4	1.3	1.1	1.6	4.9	2.4	2.2
Co	"	<0.02	b	<0.02	<0.02	<0.02	<0.02	0.011[c]
Fe	"	<0.03	<0.001	<0.03	0.4	<0.03	<0.03	0.041[c]
Ga	"	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hf	"	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
K	"	0.1	<0.1	0.2	0.2	0.4	0.1	0.1
Li	"	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mg	"	0.52	0.5	1.3	0.13	0.28	0.2	0.19
Mn	"	<0.003	<0.016[c]	0.0072	0.016	0.0063	0.017	0.034[c]
Mo	"	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Na	"	2.1	2.2	2.2	1.4	1.8	1.3	1.6
P	"	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Si	"	2.7	2.7	2.8	2.2	2.0	2.7	2.8
Sr	"	<0.005	<0.005	0.01	<0.005	0.015	0.0062	0.0059
Ti	"	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
V	"	<0.03	<0.007	<0.03	<0.03	<0.03	<0.03	<0.006[c]
Zn	"	0.039	0.041	0.08	0.029	<0.02	0.073	0.095[c]
Zr	"	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06

[a] Samples WB-802-1 and WM-0039-1 are duplicate samples obtained for quality assurance analyses.

[b] Recovery of spike to QA sample was less than 100%, therefore no sample concentration can be computed.

[c] Value is computed on the basis of remainder values in excess of 100% spike recovery from QA sample. Refer to section for spike recovery data.

performance of a gamma scan. Table 18 presents the results of the radiological analyses. Well WM-0039 contains the highest tritium levels (2.3E6 pCi/L), Well WM-0074 has the second highest (2.6E4 pCi/L), followed by Well WM-0035. Tritium was essentially undetected in the background well and in the downgradient well. Well WM-0035 had minor alpha and beta activity. All other values reported represent detection limit values for the analyses. The tritium levels measured in Wells WM-0039 and WM-0074 are in excess of the 2.0E4 pCi/L primary drinking water standard.

Organic Parameters

Total organic carbon (TOC) and total organic halogen (TOX) analyses were performed on all the water samples. Results of these analyses are presented in Table 19. TOC and TOX are low in all the samples.

Table 20 summarizes the results of the HAP screen for the water samples collected at Barnwell, South Carolina. Here, as for the Sheffield samples, only a few classes of organic compounds could be eliminated by the screen.

The results for the determination of specific volatile and semi-volatile organic constituents in the Barnwell water samples are summarized in Tables 21 and 22. The solvents chloroform, trichloroethylene, and tetrachlorothylene appear to be the only detectable volatile organic constituents. Chloroform was detected in all samples and trichloroethylene and tetrachlorothylene were detected in samples WM-0039, and WM-0074. Only the chloroform content in the sample from Well WM-0039, WM-0074, and WM-0039 exceed the detection limits listed (Ref. 4) in Method 624. For the semi-volatile organic constituents only sample, WM-0035, appears to have any significant organic content. This sample appears to have a very significant hydrocarbon content is probably related to petroleum products (gasoline, diesel fuel, motor oil, etc.).

As indicated in footnote X of Table 22 there are numerous organic compounds estimated to be present in the 5-100 ppb range. These compounds are generally common to petroleum products thus indicating that this well may have been exposed to such products. Although these concentrations are certainly significant for organic compounds in water, Method 1625 does not

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Table 18

Results of Radiological Analyses of Ground Water Samples from Barnwell, S.C. (5/14/85)

Parameter	Well WB-802	Well WB-802-1	Well WB-102	Well WM-0035	Well WM-0074	Well WM-0039	Well WM-0039-1
Tritium	810±945	1188±972	<810	1674±999	2.7E4±1.9E3	2.3E6±8.1E4	2.3E6±8.1E4
Gross alpha	0.51±2.24	2.16±2.97	2.702.971	16.47±5.94	2.16±3.24	2.16±2.7	0.92±2.35
Gross beta	1.62±2.7	4.32±2.97	<2.7±2.97	9.45±3.51	0.76±2.62	2.7±2.97	1.62±2.7
Cs-137	<13.5	<13.5	<10.8	<10.8	<10.8	<8.1	<10.8
Co-60	<16.2	<13.5	<10.8	<8.1	<10.8	<13.5	<13.5

All values are pCi/L.

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Table 19

Results of Total Organic Carbon and Total Organic Halides Analyses, Barnwell Water Samples (5/14/85)

Parameter	Unit of Measurement	Well WM-0035	Well WM-0039	Well WM-0039-1[a]	Well WM-0074	Well WB-102	Well WB-802	Well WB-802-1[a]
TOC	g/ml	1.9	0.97	0.91	0.29	0.45	0.24	0.54
TOX	g/L	10	7	7	5	7	7	10

[a] Samples WM-0039-1 and WB-802-1 are duplicate samples obtained for QA purposes.

Table 20

Summary Showing Which Tables of Organic Compounds Could Not Be Eliminated by HAP Screen for Barnwell Water Samples

Sample	Table Nos.					
	3	3B	4	5	6	7
WM-0039	X	X	X	X	-	-
WM-0035	X	X	X	X	-	X
WB-102	X	X	X	-	-	-
WM-0074	X	X	X	X	-	-
WB-802	X	X	X	X	-	-
WM-0039-1	X	X	X	-	-	-

(X)indicates a table that could not be eliminated.
(-)indicates a table that could be eliminated.

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Table 21

Volatile Organic Compounds in Barnwell, South Carolina Samples (5/14/85)

Compound	NPDES ID	Limit	Sample Identification						
			WB-802	WM-39	WM-35	WB-102	WM-74	WB-802	WM-39-1
Bromoform	05V	1	<1	<1	<1	<1	<1	<1	<1
Carbon tetrachloride	06V	10	<10	<10	<10	<10	<10	<10	<10
Chlorobenzene	07V	10	<10	<10	<10	<10	<10	<10	<10
Chlorodibromomethane	08V	1	<1	<1	<1	<1	<1	<1	<1
Chloroform	11V	1	1	14	1	1	8	1	12
Dichlorobromomethane	12V	1	<1	<1	<1	<1	<1	<1	<1
1,2-dichloroethane	15V	10	<10	<10	<10	<10	<10	<10	<10
Methylene chloride	22V	10	<10	<10	<10	<10	<10	<10	<10
1,1,2,2-tetrachloroethane	23V	10	<10	<10	<10	<10	<10	<10	<10
Tetrachloroethylene	24V	1	<1	<1	<1	<1	1	<1	1
1,1,1-trichloroethane	27V	10	<10	<10	<10	<10	<10	<10	<10
1,1,2-trichloroethane	28V	10	<10	<10	<10	<10	<10	<10	<10
Trichloroethylene	29V	1	<1	1	<1	<1	<1	<1	<1

All concentrations are µg/L.

Table 22

Semi-volatile Organic Constituents in the Barnwell, South Carolina Samples (5/14/85)

Compound	NPDES Code	Detection Limit[a]	Sample						
			WB-802	WM-39	WM-35	WB-102	WM-74	WB-802	WM-39
2-Chlorophenol	1A	10							
2,4-Dichlorophenol	2A	10							
2,4-Dimethylphenol	3A	10							
4,6-Dinitro-O-Cresol	4A	10							
2,4-Dinotrophenol	5A	10							
2-Nitrophenol	6A	10							
4-Nitrophenol	7A	10							
P-Chloro-M-Cresol	8A	10							
Pentachlorophenol	9A	10							
Phenol	10A	10							
2,4,6-Trichlorophenol	11A	10							
Acenaphthene	1B	10							
Acenaphtylene	2B	10							
Anthracene	3B	10							
Benzidine	4B	10							
Benzo(a)anthracene	5B	10							
Benzo(a)pyrene	6B	10							
3,4-Benzofluoranthene	7B	10							
Benzo(ghi)Perylene	8B	10							
Benzo(k)fluoranthene	9B	10							
Bis(2-Chloroethoxy) Methane	10B	b							
Bis(2-Chloroisopropyl) Ether	11B	b							
Bis(2-Chloroisopropyl) Ether	12B	b							
Bis (2-Ethylhexyl) Phthalate	13B	10							
4-Bromophenyl Phenyl	14B	b							
Butyl Benzyl Phthalate	15B	10							
2-Chloronaphthalene	16B	10							
4-Chlorophenyl Phenyl Ether	17B	b							
Chrysene	18B	10							
Dibenzo(a,h)Anthracene	19B	10							
1,2-Dichlorobenzene	20B	10							
1,3-Dichlorobenzene	21B	10							
1,4-Dichlorobenzene	22B	10							
3,3'-Dichlorobenzidine	23B	b							
Diethyl Phthalate	24B	10							
Dimethyl Phthalate	25B	10							
Di-N-Butyl Phthalate	26B	10	0	0	0	0	0	23	0
2,4-Dinitrotoluene	27B	10							
2,6-Dinitrotoluene	28B	10							
Di-N-Octyl Phthalate	29B	10	26	0	65	32	0	32	
1,2-Diphenylhydrazine (as Azobenzene)	30B	b							
Fluoranthene	31B	10							
Fluorene	32B	10							
Hexachlorobenzene	33B	10							
Hexachlorobutadiene	34B	10							
Hexachlorocyclo-pentadiene	35B	10							
Hexachloroethane	36B	10							
Indeno(1,2,3-cd)pyrene	37B	10							
Isophorene	38B								
Naphthalene	39B	10							
Nitrobenzene	40B	10							

Table 22 (Continued)

Semi-volatile Organic Constituents in the Barnwell, South Carolina Samples

Compound	NPDES Code	Detection Limit[a]	Sample WB-802	WM-39	WM-35	WB-102	WM-74	WB-802	WM-39
N-Nitrosodimethylamine	41B	b							
N-Nitrosodi-N-Propylamine	42B	b							
N-Nitrosodiphenylamine	43B	b							
Phenanthrene	44B	10							
Pyrene	45B	10							
1,2,4-Trichlorobenzene	46B	10							
Aldrin	1P	10							
-BHC	2P	10							
-BHC	3P	10							
-BHC	4P	10							
-BHC	5P	10							
Chlordane	6P	b							
4,4'-DDT	7P	10							
4,4'-DDE	8P	10							
4,4'-DDD	9P	10							
Dieldrin	10P	10							
-Endosulfan	11P	10							
-Endosulfan	12P	10							
Endosulfan Sulfate	13P	10							
Endrin	14P	10							
Endrin Aldehyde	15P	b							
Heptachlor	16P	10							
Heptachlor Epoxide	17P	10							
PCB-1242	18P	b							
PCB-1254	19P	b							
PCB-1221	20P	b							
PCB-1232	21P	b							
PCB-1248	22P	b							
PCB-1260	23P	b							
PCB-1016	24P	b							
Toxaphene	25P	b							
Other Compounds					X				
Cyclohexanol			10	20		20			
Cyclohexanone			D						
Sulfur				D		D	D		D
Epoxy Cyclohexane							D		
2,2,4-trimethyl penta-1,3-diol di isobutyrate					D				

[a] Units are ppb based on original sample.

No entry means that compound was not detected.

b - No detection limit has been determined.

D - Compound detected at concentration less than 10 ppb.

X - Numerous hydrocarbons were detected in the range of 5 to 100 ppb. These included several isomers of trimethyl cyclohexane, 3-methyl tetracosane, 4-methyl decane, 4-ethyl heptane, and some 40 additional hydrocarbons that could not be completely identified from electron impact mass spectra.

include specific calibrations for such compounds. In addition simple electron impact mass spectrometry can not unequivocally identify such compounds because such hydrocarbons have similar fragmentation patterns.

3.2.3 Quality Assurance Assessment - Barnwell Analytical Program

Measures taken to quantify the analytical accuracy of the Barnwell analytical program are similar to those used in the Sheffield analyses. Two duplicate samples were spiked with an EPA quality control material which was also analyzed as a blind control sample. An organic standard was prepared at ORNL and was submitted for analysis along with the Barnwell ground water samples.

Table 23 presents EPA data on the quality control material used including average concentrations, percent error at the 95% confidence interval (2σ), the value obtained by ORNL for the material, and the percent deviation of the ORNL value from the EPA average. The ORNL results are within the 95% confidence interval for most elements with the exception of Ni which was determined by atomic absorption. The inductively coupled plasma determination for the sample was within the 95% confidence interval.

Table 24 presents results of analyses of the two spiked ground water samples. This table shows the analytical recovery of the EPA QC material spiked into natural waste samples with a relatively complex chemical composition. In such a situation, the potential exists for chemical effects which lead to incomplete spike recovery or chemical interference in analyses. The spiked concentrations were above the regulatory limits for the EPA toxic metals and for some analyses, dilutions were required to bring the sample concentrations into the proper range for analysis. The process of sample dilution also introduces error in the final analytical value.

The table includes the value determined on the unspiked duplicate sample and the spike concentration added. For elements which were detected above the detections limit, the detected value plus spike concentration should be detected in the spiked sample. For elements which were reported below detection limit in the unspiked sample a range of expected concentration is computed assuming that the true value lies between 0 and

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Table 23

Analytical Results and Deviation for EPA Inorganic Control Material Barnwell Analytical Program

Element	EPA Average Concentration µg/ml	95% Confidence Interval	ORNL Concentration µg/ml	% Deviation from EPA Average
Al	0.745	±17%	0.72	-3
As	0.234	±22%	0.26	+11
Be	0.232	±11%	0.24	+4
Cd	0.0369	±16%	0.041	+11
Cr	0.258	±19%	0.21	-19
Co	0.259	±12%	0.27	+4
Cu	0.335	±10%	0.34	+2
Fe	0.789	±12%	0.83	+5
Pb	0.430	±14%	0.47	+9
Mn	0.346	±12%	0.37	+7
Hg	0.00850	±30%	0.0061	-28
Ni	0.206	±14%	0.17 AA 0.22 ICP	-18 AA +7 ICP
Se	0.0469	±33%	0.046	-2
V	0.864	±16%	0.88	+2
Zn	0.415	±8%	0.45	+8

Table 24

Results of Inorganic Quality Control Analyses - Barnwell Analytical Program
Concentrations in μg/ml

	BACKGROUND WELL					WELL NEAR TRENCHES				
Element	Unspiked Sample Concentration	Spike Concentration		Spiked Sample Concentration	Maximum % Error	Unspiked Sample Concentration	Spike Concentration		Spiked Sample Concentration	Maximum % Error
		EXPECTED RANGE					EXPECTED RANGE			
Al	<0.2	0.365	<0.565	0.36	-1% - -36%	<0.2	0.745	<0.945	0.7	-6% - -33%
As	<0.001	0.118	<0.119	0.096	-19%	<0.001	0.234	<0.235	0.29	+24% - +23%
Be	<0.001	0.118	<0.119	0.12	+0.8%	<0.001	0.232	<0.233	0.24	+4% - +3%
Cd	0.004	0.0195	0.235	0.022	-6%	0.005	0.0369	0.0419	0.045	+7%
Cr	<0.001	0.131	<0.132	0.13	-2%	<0.001	0.258	<0.259	0.28	+8% - +9%
Co	<0.02	0.131	<0.133	0.13	-2%	<0.02	0.259	<0.279	0.27	-3% - +4%
Cu	0.003	0.170	0.173	0.14 AA 0.18 ICP	-19% +4%	0.014	0.335	0.349	0.41	+18%
Fe	<0.03	0.399	<0.429	0.4	-7% - -0.3%	<0.03	0.789	<0.819	0.83	-1% - +5%
Pb	0.001	0.218	0.219	0.19	-13%	0.005	0.430	0.435	0.44	+1%
Mn	<0.003	0.174	<0.177	0.19	+7% - +9%	0.017	0.346	0.363	0.38	+5%
Hg	<0.00005	0.00437	<0.0044	0.0036	-18%	<0.00005	0.00850	<0.0086	0.0076	-12% - -11%
Ni	<0.005	0.104	<0.109	0.12	+10% - +15%	<0.005	0.206	<0.211	0.18 AA 0.22 ICP	-15% - -13% +4% ICP
Se	<0.001	0.0251	<0.0261	0.021	-16% - -20%	<0.001	0.0469	<0.0479	0.048	+2% - +0.2%
V	<0.03	0.423	<0.426	0.43	+0.9% - +2%	<0.03	0.864	<0.894	0.87	-3% - +0.7%
Zn	0.039	0.209	0.248	0.25	+0.8%	0.073	0.415	0.4880	0.51	+5%

the detection limit. The expected range of concentration in the spiked sample then ranges from the spike concentration (if the true value is 0) to the spike plus detection limit (if the true value is equal to the detection limit). The maximum percent error is then expressed as a single value for those elements detected above detection limits (for example Cd, Cr, Pb, and Zn) and as a range of possible maximum error for elements present at less than the detection limit.

The data in Table 24 show that for most elements, recovery of the spike was good. Recovery of arsenic, copper, nickel, lead, and selenium was variable between the two spikes. Mercury recovery was low and was consistent with the low recovery obtained in the EPA QC material analyzed as a blind sample. Analysis of EPA standards concurrently with these samples provided results accurate within 5 percent for Cu, Ni, Pb, Cr, and Hg and within 10% for As and Se. Therefore, we conclude that the difficulty with spike recovery is related to chemical interactions with the sample water or to errors in performance of dilution. The maximum percent error determined from spike recovery has no effect on interpretation of results on the unspiked samples because all detected values for the EPA toxic metals were at least an order of magnitude below the primary drinking water standard (Section 3.2.4).

Table 25 summarizes the recovery of D10-phenanthrene for the extraction of nine different samples associated with the analysis of the water samples from Barnwell. These recovery values were used to adjust any final quantitative evaluations of the semi-volatile constituents. In brief, these recoveries are quite consistent for real samples and compare favorably with recovery ranges shown for EPA Methods (Ref. 3).

3.2.4 Comparison of Analytical Results to Ground Water Protection Standards

The results of analyses performed in this reconnaissance study of the Barnwell site show that heavy metal concentrations were at least one order of magnitude below the National Interior Primary Drinking Water Standard (PDWS) in all samples analyzed. Tritium was two orders of magnitude higher

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Table 25

Extraction Recovery of D10-Phenanthrene in the Set of Water Samples Associated with Barnwell

Sample	Recovery
WB-802-1 (upgradient)	86%
WM-0039	86%
WM-0035	81%
WB-102	76%
WM-0074	79%
WB-802	52%
WM-0039-1	76%
801 (blank with spike)	100%
901 (blank with spike)	100%

than the PDWS in Well WM-0039 and was about 23% higher than the PDWS in Well WM-0074. Both of these wells are located adjacent to disposal trenches. Well WM-0035 contained approximately 16±6 pCi/L alpha activity and approximately 10±4 pCi/L beta activity. No other wells had significant radiological constituents.

The organic analytical program detected very low concentrations of only a few compounds in the Barnwell water samples. Traces to low concentrations of chloroform were detected in water samples from all wells. Traces of dichlorobromomethane and trichloroethylene were detected in one sample from Well WM-0039. Traces of tetrachloroethylene were detected in samples from WM-0039 and WM-0074. The sample from Well WM-0035 contained aliphatic hydrocarbons.

Tritium was the principal mobile constituent detected in ground water in this study.

4.0 CONCLUSIONS

This reconnaissance study was undertaken to determine the extent of migration of EPA listed hazardous substances (RCRA Appendix VIII) from low-level radioactive waste disposal trenches at Sheffield, Illinois, and Barnwell, South Carolina. At both sites, tritium appears to be the principal mobile constituent. At the Barnwell site, the results of inorganic and organic analyses showed only traces to very low concentrations of listed compounds in ground water adjacent to disposal trenches. At the Sheffield site, volatile organic compounds were detected at elevated concentrations (hundreds to thousands of parts per billion) in all the samples. Tritium was detected at levels above the primary drinking water standard in two wells downgradient of the site. Inorganic parameters were well below the drinking water and RCRA ground water protection limits (40 CFR 264).

The detection of volatile organic compounds in downgradient wells at Sheffield, and the apparent correlation between tritium and volatile organic compounds suggests a common source of both. The proximity of the Chemical Waste Disposal site to the low-level site raises questions regarding the source of organics. Determination of the potential for migration of organic compounds from the Chemical Waste Disposal Site through the low-level waste site is beyond the scope of this reconnaissance study.

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2. U.S. Environmental Protection Agency, (EPA). Proposed Sampling and Analytical Methodologies for Addition to Test Methods for Evaluating Solid Waste Physical/Chemical Methods, NTIS PB85-103026.

3. Federal Register, Vol. 49, No. 209, October 26, 1984. pp. 43234-43442.

4. U.S. NRC, 1982, Environmental Assessment for the Barnwell Low-Level Waste Disposal Facility. NUREG-0879.

APPENDIX A

PRIMARY DRINKING WATER STANDARDS

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Maximum Contaminant levels (MCLs) Established Under the National Interim Primary Drinking Water Regulations (40 CFR 141)

Contaminant	MCL
Arsenic (mg/L)	0.05
Barium (mg/L)	1
Cadmium (mg/L)	0.010
Chromium (mg/L)	0.05
Lead (mg/L)	0.05
Mercury (mg/L)	0.002
Nitrate-N (mg/L)	10
Selenium (mg/L)	0.01
Silver (mg/L)	0.05
Fluoride (mg/L)	1.4-2.4[a]
Endrin (mg/L)	0.0002
Lindane (mg/L)	0.004
Methoxychlor (mg/L)	0.1
Toxaphene (mg/L)	0.005
2,4-D (mg/L)	0.1
2,4,5-TP Silvex (mg/L)	0.01
Total trihalomethanes (mg/L)	0.10
Coliform bacteria	d
Combined radium-226 and radium-228 (pCi/L)	5
Gross alpha particle activity including Ra but excluding U and Rn (pCi/LO	15
Man-made beta- and photon-emitting radionuclides -- dose-rate limit to whole body or any organ of 4 mrem/y; a few nuclide-specific concentration limits (pCi/L) associated with the dose-rate limit are given below	
H-3	20,000
Co-60	100
Sr-90	8
I-131	3
Cs-137	200

---

[a]Depending on annual average maximum daily average air temperature.

APPENDIX B

TENTATIVE IDENTIFICATION OF SPECIFIC ORGANIC COMPOUNDS DETECTED

TENTATIVE IDENTIFICATION OF SPECIFIC ORGANIC COMPOUNDS DETECTED

In a preliminary transmittal several compounds were listed in a table (copy attached) with their estimated concentrations. This list of compounds included several volatile compounds [trichloromethane, trichloroethane, perchloroethylene, and trichloroethylene], and semi-volatile compounds [cyclohexene, dioxane, some compounds related to cyclohexene at very low levels, and two major (greater than 10 ppb) components described as an unknown glycol with a nitrogen ... and a hydrocarbon with a chlorine and/or an oxygen function]. As indicated in the table of the preliminary report, all the concentrations "... were estimated from ... various gas chromatograms generated by the application of the Appendix VIII Methods ..." At that time identifications were based on a single Gas Chromatography/Mass Spectrometry run of a single combined acid and base-neutral extract from Trench 18. (See Footnote (a) of attached table.)

Initially, only the Appendix VIII screening methods had been planned for these water samples. However, the results from the screen indicated that there was a definite organic content in the water with concentrations which varied over the site. Thus it was decided to perform a more thorough analysis on these samples following the EPA 600 methods which start with a much larger water sample and are designed for the analysis of specific components. Specifically, EPA Method 1625 was carried out resulting in Table 13 of the final report. This method covers some eighty semi-volatiles listed in Table 5 of the final report. In addition, this method was expanded to identify and estimate the major constituents not listed in Table 5, ("Other Compounds Detected" listed in Table 13). Results from Method 1625 should be considered more reliable than the estimate presented in the preliminary report. However as specified in Table 13, these results are for semi-volatile organic compounds only.

Volatile results for these samples should be regarded as minimum concentrations for two reasons: (1) the sample had aged before it was decided to apply the more specific (quantitative rather than screening) methods and (2) volatile samples were aliquots from bulk samples rather than

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aliquots from sealed volatile sample vials. Thus it is quite likely that any data for true volatiles (volatile compounds not soluble in water such as chloroform, perchloroethylene and trichloroethane) would be low because of losses due to sample aging, etc. Thus no volatiles were reported in the final report.

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Organic Content[a] of Water Samples from Sheffield, Illinois

Component	Sample Origin				
		Well No.			
	Trench 18	523	563	574	575
Trichloromethane	15	<1	<1	nd	nd
Trichloroethane	1	1	<1	nd	nd
Benzene ?	<1	nd	nd	nd	nd
Cyclohexene	>15	>10	>5	nd	X
Trichloroethylene ?	1	<1	<1	nd	nd
Dioxane	>15	11	5	nd	3
Perchloroethylene	11	4	1	nd	nd
Cyclohexene Oxide	1	<1	<<1	nd	nd
Cyclohexenol	<1	<<1	nd	nd	nd
Unknown - Glycol with Nitrogen function (M.W. 91)?[b]	X	X	X	nd	nd
Methyl cyclohexene ?	X	X	nd	nd	nd
Unknown - chlorinated Oxygenated hydrocarbon (M.W. 249)?[b]	X	X	nd	nd	X

[a] Quantites listed in Table have units of parts-per-billion (ppb). Entries marked with an X indicate that the compound was detected but not quantitated; nd indicates not detected. Quantities were estimated from chromatographic areas of the various gas chromatograms generated by the application of the Appendix VIII methods (8010, 8015, 8030, and 8620). Identifications are based on a GC/MS study of the combined acid and base-neutral extracts of the water with highest organic content (Trench 18).

[b] These compounds can not be tentatively identified from their mass spectra; however, based on the intensity of their peaks in the chromatogram, both are major organic constituents. Therefore, they are listed along with their apparent molecular weight.

APPENDIX C

RESULTS OF SEPTEMBER 1985
GROUND WATER SAMPLING AND ANALYSES
SHEFFIELD, ILLINOIS

by

R.H. Ketelle
Oak Ridge National Laboratory

RESULTS OF SEPTEMBER 1985 GROUND WATER SAMPLING AND ANALYSES SHEFFIELD, ILLINOIS

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RESULTS OF SEPTEMBER 1985 GROUND WATER SAMPLING AND ANALYSES
SHEFFIELD, ILLINOIS

1.0 INTRODUCTION

In September 1985, personnel from Oak Ridge National Laboratory obtained a suite of ground water samples for the U.S. Nuclear Regulatory Commission (NRC) from the U.S. Ecology Low-Level Radioactive Waste Disposal (LLWD) Site. Samples were collected from seven monitoring wells located within and adjacent to the LLWD site. The purpose of the project is to investigate the presence and migration of non-radiological contaminants in the vicinity of the LLWD site. This study is a follow up to work performed and reported previously (Ref. 1). Parameters included in the analytical program include dissolved metals, anions, total organic carbon, total organic halogen, tritium, and organic compounds including volatile and extractable compounds. The organic analyses included performance of the Method 8600 screening analyses as well as EPA Methods 624 and 625. The analytical procedures used in this study are the same as those used previously (Ref. 1) and that report includes discussions of analytical protocols.

The locations of wells sampled in January and September 1985 are shown on Figure 1. The September sampling included all numbered wells except T-18.

2.0 FIELD PROCEDURES

Wells were purged and sampled by hand bailing. Wells with sufficient yield were purged of stagnant water by bailing a minimum of approximately three well volumes prior to sampling. Three wells (150, 523, 534) yielded water slowly enough to permit purging by bailing to dryness. These wells were bailed dry and allowed to recover prior to sampling. Physicochemical parameters including temperature, pH, specific conductance and dissolved oxygen were measured and recorded periodically during bailing. The oxidation-reduction potential (redox potential) was measured in the lab immediately after sampling. Well information and physicochemical data are tabulated for each well in the field data logs in Attachment 1.

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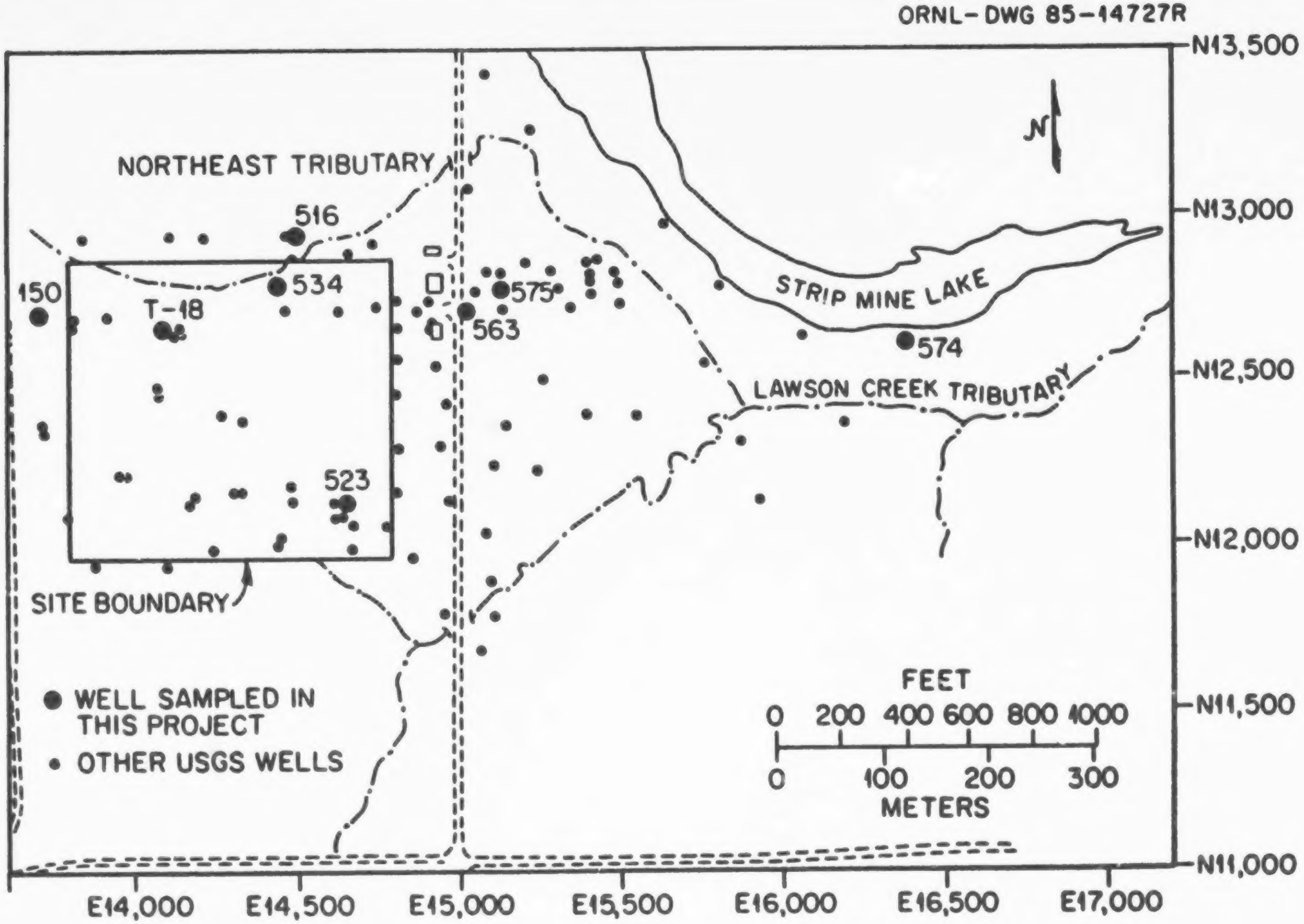
ORNL-DWG 85-14727R
N13,500
N13,000
N12,500
N12,000
N11,500
N11,000
E14,000
E14,500
E15,000
E15,500
E16,000
E16,500
E17,000
N
NORTHEAST TRIBUTARY
STRIP MINE LAKE
LAWSON CREEK TRIBUTARY
SITE BOUNDARY
516
534
150
T-18
575
563
574
523
● WELL SAMPLED IN THIS PROJECT
• OTHER USGS WELLS
FEET
0 200 400 600 800 1000
0 100 200 300
METERS

Fig. 1. Locations of wells sampled at Sheffield, Illinois.

Samples were obtained using bailers and were transferred into appropriate containers with preservatives and stored on ice or refrigerated from the time of collection to the time of analysis. Samples collected for the analysis of dissolved metals were filtered through 0.45 micron Millipore filter paper prior to acidification to pH <2 with nitric acid. Samples for volatile organic constituent analyses were collected using a teflon, closed top bailer, on wells 150, 516, 563, 574, and 575. Water levels in Wells 523 and 534 were too low for use of the closed top bailer, consequently a stainless steel bailer with a teflon check valve was used to collect these samples.

3.0 RESULTS OF ANALYSES

3.1 Inorganic, Screening Organic, and Tritium Analyses

Analytical results obtained for inorganic parameters, screening level organic parameters, and tritium are included in Table 1. Comparison of results obtained for inorganic parameters and tritium between the September 1985 sampling program and the January 1985 sampling indicates that only minor variations in parameter concentrations were detected between the two data sets.

Total organic carbon (TOC) and total organic halogen (TOX) analyses were performed on the samples and are reported in Table 1. TOC results appear reasonable, however, the TOX values are extremely high and are regarded as unreliable for these samples. The TOX values reported do not show proportionality with TOC or other organic analytical results for the samples. Instrument error has been eliminated as a cause of the high values since instrument calibration was checked between samples and blanks were analyzed between samples to ensure proper instrument operation. The high TOX values are attributed to an unidentified source of interference within the samples.

Table 1

RESULTS OF WATER ANALYSES[a]

SHEFFIELD, ILLINOIS LLWD SITE

Parameter	Well 523	Well 563	Well 574	Well 575	Well 150	Well 534	Well 516
Metals							
Ag	<0.0002[b]	<0.05	<0.0002[b]	<0.05	<0.0002[b]	<0.0002[b]	<0.0002[b]
Al	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
As	<0.003[c]	<0.10	0.002[c]	<0.10	0.017[c]	0.002[c]	<0.002[b]
B	5.9	2.1	0.44	0.45	<0.08	0.12	<0.08
Ba	<0.1[b]	0.12	<0.1[b]	0.20	0.37[b]	<0.1[b]	<0.1[b]
Be	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Ca	170	190	110	190	120	52	110
Cd	<0.0001[b]	<0.005	0.0001[b]	<0.005	<0.0003[b]	0.0001[b]	0.0001[b]
Co	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cr	<0.009[b]	0.04	0.004[b]	<0.04	0.006[b]	0.003[b]	0.006[b]
Cu	<0.02	<0.02	0.005[b]	<0.02	0.006[b]	0.007[b]	0.007[b]
Fe	3.4	0.44	1.1	5.2	0.17	0.40	0.55
Ga	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Hg	<0.00005	d	<0.00005	d	<0.00005	<0.00005	<0.00005
K	3.3	0.8	3.0	1.0	1.6	1.6	0.9
Li	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Mg	140	55	39	57	37	25	40
Mn	0.39	1.9	0.14	1.7	0.46	0.095	0.15
Mo	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Na	41	13	37	14	8.9	9.4	10
Ni	<0.01[b]	<0.06	<0.01[b]	<0.06	<0.01[b]	<0.01[b]	<0.01[b]
P	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Pb	<0.007[b]	<0.20	0.003[b]	<0.20	0.006[b]	0.004[b]	0.004[b]
Sb	<0.005[b]	<0.20	<0.005[b]	<0.20	<0.005[b]	<0.005	<0.005[b]
Se	<0.005[c]	<0.20	<0.005[c]	<0.20	<0.005	<0.005[c]	<0.005[c]
Si	8.1	10	8.2	13	8.0	2.2	10
Sr	0.18	0.056	0.60	0.048	0.23	0.088	0.046
Ti	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
V	0.071	0.071	0.062	0.065	0.061	0.036	0.063
Zn	0.03	0.032	<0.02	0.038	0.034	<0.02	<0.02
Zr	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Anions							
Br	<5	<5	<5	<5	<5	<5	<5
Cl	23	19	4	12	1	4	17
CO_3	0	0	0	0	0	0	0
HCO_3 (mg/L)	1134	572	438	548	456	226	386
F	<1	<1	<1	<1	<1	<1	<1
NO_2	<5	<5	<5	<5	<5	<5	<5
NO_3	<5	5	<5	<5	<5	<5	<5
PO_4	<5	<5	<5	<5	<5	<5	<5
SO_4	120	150	69	180	16	46	53
Other							
TOC	33	29	5.3	7.3	4.6	4.1	3.6
TOX[e] µg/L	6.0×10^5	1.5×10^5	1.1×10^5	1.9×10^5	2.9×10^5	1.6×10^5	9.3×10^4
Tritium pCi/L	$4.32 \times 10^5 \pm 2.7 \times 10^4$	$1.92 \times 10^5 \pm 2.7 \times 10^3$	$<5.1 \times 10^2$	$1.78 \times 10^5 \pm 2.7 \times 10^3$	$<8.1 \times 10^2$	$<8.1 \times 10^2$	$<8.1 \times 10^2$

[a] All concentrations are µg/ml unless otherwise indicated.

[b] Metals analyzed by graphite furnace atomic absorption. Other metals were analyzed by ICP.

[c] Arsenic and selenium were analyzed by the metal hydride method.

[d] Mercury analyses were not performed on these samples.

[e] TOX values are unrealistically high.

3.2 Organic Analyses

The organic analytical program included analyses by EPA Methods 624, and 625 for detection and identification of volatile and extractable compounds. Volatile compounds identified and concentrations present are listed in Table 2. Very high concentrations of EPA listed volatile compounds were detected in four of the seven wells sampled. The suite of volatile compounds detected was fairly consistent in three of the wells which contained high concentrations. Wells 523, 563, and 575 contained very high concentrations of 1,1,1-trichloroethane. The concentrations present exceed the instrument calibration range and are reported in Table 2 as being greater than 1,000 ppb. Estimated actual concentrations of 1,1,1-trichloroethane in these wells are 12 ppm in well 523, 3.2 ppm in well 563 and 2.5 ppm in well 575. Well 516 contained a similar suite of compounds but in different proportions, with tetrachloroethylene predominating at an estimated concentration of 1.4 ppm. Well 523, located adjacent to a trench has the highest concentration of volatiles. Wells 563 and 575, located in the seepage plume pathway have a similar assemblage of volatile compounds as those found in Well 523 but in slightly lower concentrations. Well 574, the background well, contains only trace concentrations of 1,1,1-trichloroethane and metnylene chloride. Very low concentrations of volatiles were detected in Wells 150 and 534. Well 516 had high concentrations of volatiles which are attributed to an undocumented chemical waste disposal near that well prior to operation of the Chemical Waste Disposal Site.

Extractable organic compounds detected and reported by EPA Method 625 are listed in Table 3. Bis(2-ethylhexyl)phthalate was detected in several samples and petroleum derived hydrocarbons were detected in five of the seven well samples. Table 4 lists other semi volatile compounds detailed but not included in the required reporting list of EPA Method 625. These compounds include petroleum fuel compounds and petroleum solvent derived compounds (cyclohexene related compounds), and oil and grease type hydrocarbons as well as sulfur, and a high molecular weight oxygenated hydrocarbon which was detected in well 575.

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Table 2

Volatile Organic Compounds Determined According to EPA Method 624[a]

Compound	NPDES ID	Well No. 523	563	574[b]	575	150	534	516
Trans 1,3-dichloropropene	3				<1			
Benzene	4	3			<1		<1	85
Chlorobenzene	7	<1						<1
1,1,2-trichloroethane	14	<1			<1		<1	
1,1,2,2-tetrachloroethane	15	<1						
1,2-dichloropropane	32	4						4
Cis 1,3-dichloropropene	33	<1						
Bromoform	47							
Bromodichloromethane	48							
Dibromochloromethane	51							
Tetrachloroethylene	85	14			110			>1000[c]
Toluene	86	<1			<1		<1	<1
Trichloroethylene	87	3			10		<1	22
Carbon Tetrachloride	6	<1				6		
1,2-dichloroethane	10	2	21		9			2
1,1,1-trichloroethane	11	>>1000[c]	>1000[c]	6	>1000[c]	6		6
1,1-dichloroethane	13	320	89		117			<1
Chloroform	23	209	10		2	<1		175
1,1-dichloroethylene	29	6			5			
1,2-dichloroethylene	30		2		1	<1	<1	2
Methylene Chloride	44	7	1	1		5		12

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[a] All concentrations are ug/L; A "less than" entry indicates that the mass spectrometer may have detected the compound at a level too low to be quantitated; No entry indicates that the compound was not detected by the mass detector.

[b] Background well.

[c] These values are very high and exceed the dynamic range of the detector.

Table 3
Semivolatile Organic Constituents

Compound	NPDES Code	Detection Limit^a	Well No.						
			523	563	574	575	150	534	516
2-Chlorophenol	1A	10							
2,4-Dichlorophenol	2A	10							
2,4-Dimethylphenol	3A	10							
4,6-Dinitro-O-Cresol	4A	10							
2,4-Dinotrophenol	5A	10							
2-Nitrophenol	6A	10							
4-Nitrophenol	7A	10							
P-Chloro-M-Cresol	8A	10							
Pentachlorophenol	9A	10							
Phenol	10A	10							
2,4,6-Trichlorophenol	11A	10							
Acenaphthene	1B	10							
Acenaphtylene	2B	10							
Anthracene	3B	10							
Benzidine	4B	10							
Benzo(a)anthracene	5B	10							
Benzo(a)pyrene	6B	10							
3,4-Benzofluoranthene	7B	10							
Benzo(ghi)perylene	8B	10							
Benzo(k)fluoranthene	9B	10							
Bis(2-Chloroisopropyl) Methane	10B	b							
Bis(2-Chloroisopropyl) Ether	11B	b							
Bis(2-Chloroisopropyl) Ether	12B	b							
Bis(2-Ethylhexyl) Phthalate	13B	10	23			16	17	24	40
4-Bromophenyl Phenyl	14B	b							
Butyl Benzyl Phthalate	15B	10							
2-Chloronaphthalene	16B	10							
4-Chlorophenyl Phenyl Ehter	17B	b							
Chrysene	18B	10							
Dibenzo(a,h)anthracene	19B	10							
1,2-Dichlorobenzene	20B	10							
1,3-Dichlorobenzene	21B	10							
1,4-Dichlorobenzene	22B	10							
3,3'-Dichlorobenzidine	23B	b							
Diethyl Phthalate	24B	10						5	
Dimethyl Phthalate	25B	10							
Di-N-Butyl Phthalate	26B	10							
2,4-Dinitrotoluene	27B	10							
2,6-Dinitrotoluene	28B	10							
Di-N-Octyl Phthalate	29B	10			D				
1,2-Diphenylhydrazine (as Azobenzene)	30B	b							
Fluoranthene	31B	10							
Fluorene	32B	10							
Hexachlorobenzene	33B	10							
Hexachlorobutadiene	34B	10							
Hexachlorocyclopentadiene	35B	10							

Table 3 (Cont'd)
Semivolatile Organic Constituents

Compound	NPDES Code	Detection Limit[a]	Well No.						
			523	563	574	575	150	534	516
Hexachloroethane	36B	10							
Indeno(1,2,3-cd)pyrene	37B	10							
Isophorene	38B								
Naphthalene	39B	10							
Nitrobenzene	40B	10							
N-Nitrosodimethylamine	41B	b							
N-Nitrosodi-N-Propylamine	42B	b							
N-Nitrosodiphenylamine	43B	b							
Phenanthrene	44B	10							
Pyrene	45B	10							
1,2,4-Trichlorobenzene	46B	10							
Aldrin	1P	10							
-BHC	2P	10							
-BHC	3P	10							
-BHC	4P	10							
-BHC	5P	10							
Chlordane	6P	b							
4,4'-DDT	7P	10							
4,4'-DDE	8P	10							
4,4'-DDD	9P	10							
Dieldrin	10P	10							
-Endosulfan	11P	10							
-Endosulfan	12P	10							
Endosulfan Sulfate	13P	10							
Endrin	14P	10							
Endrin Aldehyde	15P	b							
Heptachlor	16P	10							
Heptachlor Epoxide	17P	10							
PCB-1242	18P	b							
PCB-1254	19P	b							
PCB-1221	20P	b							
PCB-1232	21P	b							
PCB-1248	22P	b							
PCB-1260	23P	b							
PCB-1016	24P	b							
Toxaphene	25P	b							
Other Compounds			X	X	X	X	X	X	X

[a] Units are ppb based on original sample.
No entry means that compound was not detected.

(b) No detection limit has been determined.

(D) Compound detected at concentration less than 10 ppb.

(X) Some aliphatic hydrocarbons were detected. Identification of such hydrocarbons by electron impact mass spectrometry is quite difficult. However, the presence of such compounds may indicate the trace contamination by petroleum-derived products.

Table 4

Approximate Concentrations[a] of Other Semivolatile Compounds

Compound	523	563	574	575	150	534	516
Cyclohexane diol				5	3	2	4
Cyclohexanone	5			10	14	1	13
Fuel hydrocarbons		b		5	b	b	b
Other petroleum hydrocarbons (oil or grease)		b	16	b	b	b	t
Sulfur	c		c	c	c	t	c
Organic sulfide	5						
High molecular weight oxygenated hydrocarbon				d			

[a] Concentrations are approximate μg/L.

(b) Fuel type hydrocarbons and other petroleum hydrocarbons (oil and grease) were detected in low concentrations in several of the wells sampled.

(c) Elemental sulfur was detected in high concentrations in several of the ground water samples.

(d) A high molecular weight oxygenated hydrocarbon was detected in the well 575 sample.

(t) Trace.

3.3 Results of Method 8600 Screening Analyses

The EPA Method 8600 Decision Matrix analytical approach was used on the Sheffield sample set for comparison with the standard EPA methods. This analytical approach involves application of various organic analytical techniques in a hierarchical sequence to determine the presence or absence of groups of organic compounds. By following the hierarchical sequence, various groups or tables may be eliminated from further analysis.

The results of the Method 8600 analyses for the Sheffield water samples are summarized in Table 5. All the samples had high UV absorbance. The pass/fail absorbance is 0.005 when measured relative to an upgradient or background sample. Three of the samples had UV absorbance lower than that of Well 574, the well used as background for the site. Four samples (Well Nos. 523, 563, 575, and 516) contained EPA Table 3 constituents (volatile and semi-volatile halogenated organics). Three samples (Well Nos. 523, 563, and 534) contained EPA Table 4 constituents (non-polar UV absorbing compounds). Three samples (Well Nos. 523, 563, and 534) contained EPA Table 5 constituents (UV active, semi-volatile polar organics). No EPA Table 6 or 7 compounds (nitrogen and phosphorus containing organics) were detected in the samples. Comparison of the results of the 8600 screen to those of the GC and GC/MS analyses indicates that comparable results were obtained for halogenated volatiles and semi-volatiles. Table 2 showed that Wells 523, 563, 575, and 516 contained high concentrations of halogenated volatile compounds which is consistent with the Method 8010 results (Table 5).

3.4 Results of Quality Assurance Analyses

Water sample splits from two wells were spiked with an EPA Quality Control Material to test the analytical accuracy for dissolved metals. Two spike concentrations were used; one for atomic absorption analyses (AA) and the other for inductively coupled plasma (ICP) analyses. The AA spike concentrations were well below the primary drinking water standards and were typically within about 10 ppb or less of the analytical detection limits. The results of the QA analyses for dissolved metals are summarized in Table 6. Spiked concentrations, found concentrations, and spike recovery are

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Table 5

Summary Showing Which Tables of Organic Compounds Could Not Be Eliminated By HAP Screen

Well No.[a]	ABS[b]	Table Nos.[c] 3 (8010)	4 (8610)	5 (8610)	6 (8620)	7 (8620)
523	>5	X	X	X	-	-
563	>5	X	X	X	-	-
575	1.35	X	-	-	-	-
150	1.10	-	-	-	-	-
534	>5	-	X	X	-	-
516	1.20	X	-	-	-	-

[a] Background well was No. 574.

[b] Absorbance at 250 nm of reversed phase isolate obtained by Method 3560, (combined isolates). The absorbance of Well No. 574 at 250 nm was 1.40. Thus it must be noted that the ultraviolet absorbance of all samples was very high; however, throughout the entire spectrum (220 nm to 310 nm) the absorbance for three extracts (Well Nos. 575, 150, and 516) was less than the absorbance of the sample extracted from the water taken from the background well.

[c] Number in parenthesis indicates the 8600 method applied.

(X) indicates a table that could not be eliminated.

(-) indicates a table that could be eliminated.

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Table 6

Results of QA Analyses of Samples Spiked With Metals

Element	Spiked Concentration for Atomic Absorption Analysis (µg/ml)	Found Concentration (µg/ml)	Spike Recovery	Spiked Concentration for ICP Analysis (µg/ml)	Found Concentration (µg/ml)	Spike Recovery	Percent Error in EPA Spike Concentration
Al	0.036	<0.2[a]		0.729	0.69-0.89	-5% - +22%[c]	± 17%
As	0.012	0.016	+33%	0.235	0.1-0.2	-57% - -15%[c]	± 22%
Be	0.012	0.0078-0.0098	-18% - -35%[c]	0.235	0.219-0.22	-7% - -6%[c]	± 11%
Cd	0.00195	0.0019	-3%	0.039	0.038	-3%	± 16%
Cr	0.013	0.011	-15%	0.261	0.28	+7%	± 19%
Co	0.013	0.016	+23%	0.261	0.23	-12%	± 12%
Cu	0.017	0.042	+147%	0.339	0.333	-2%	± 10%
Fe	0.040	0[b]	--	0.797	0.75	-6%	± 12%
Hg	0.00044	0.00025-0.0003	-32% - -43%[c]	0.00873	0.00555	-36%	± 30%
Mn	0.017	0.01	-41%	0.348	0.34	-2%	± 12%
Ni	0.010	0.005-0.015	-50% - +50%[c]	0.207	0.19	-8%	± 14%
Pb	0.022	0.021	-5%	0.435	0.436	+<1%	± 14%
Se	0.003	<0.005[a]	--	0.050	0.035-0.040	-30% - -20%[c]	± 33%
V	0.042	0.038	-10%	0.846	0.787	-7%	± 16%
Zn	0.021	0.002-0.022	-90% - +5%[c]	0.418	0.41	-2%	± 8%

[a] Analytical method used has a detection limit higher than the spiked concentration.

[b] Iron concentration in the spiked sample was so much higher than the spiked concentration that the spike was not reported.

[c] Spike recovery is computed as a range because elemental concentrations in the unspiked split were below detection limits, however, a measurable concentration was determined in the spiked sample.

[d] Percent error is at the 95% confidence interval for the EPA quality control check sample.

tabulated for each spiked sample. The concentration error of each metal in the EPA material is also included in Table 6. For cases in which metal concentrations in the unspiked split were below the detection limit for the analytical technique, a range of recovery is reported. The recovery range is defined by assuming that the true initial sample concentration was between zero and the reported detection limit. The spike recovery is used as a measure of the accuracy of the analyses. The spike recoveries obtained in the QA analyses are typically within the confidence limits of the QA spike material with exceptions for As, Be, Co, Cu, Hg, and Mn at the AA spike level.

Quality assurance measures used in the organic analytical program included preparation and analysis of an organic spike to deionized water and addition of deuterated standards to samples extracted for semivolatile analyses. The organic spike solutions contained volatile and semivolatile compounds in concentrations several times the detection limit for GC and GC/MS analyses. This solution was prepared prior to the sampling trip and was stored in a laboratory freezer. Two 40 ml vials of deionized water were spiked for GC analysis of volatiles and one, one liter bottle of deionized water was spiked for extraction and GC/MS analysis of semivolatiles.

Table 7 is a listing of recovery factors for the organic compounds spiked into deionized water. Recovery of three volatile compounds was approximately 125% and 163% from each sample, respectively. Possible reasons for the higher-than-anticipated recovery include difficulties in obtaining total mixing in the sealed vials and higher-than-calculated volatile concentrations in the spike sample due to insufficient warming of the standard prior to spiking. Recovery of the two semivolatile compounds spiked was 13% and 26%, respectively. The poor recovery is attributed to lower-than-calculated semivolatile content due to insufficient warming of the standard prior to spiking.

Recovery factors for the deuterated standards spiked into each sample analyzed for semivolatiles prior to the extractions are listed in Table 8. These recovery factors are generally lower than normal for the ORNL organic analytical laboratory which typically obtains recovery factors higher than 0.7 for the deuterated standards. The deuterated spike recovery factor for the well 574 sample (background well) was good. This well produces low

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Table 7

Recovery of Organic QA Spikes

Compound	Type	QA-1	QA-2	QA-3
Chloroform	V	133%	163%	-
Toluene	V	121%	161%	-
Trichloroethylene	V	125%	172%	-
Napthalene	S	-	-	26%
Dibutylphthalate	S	-	-	13%

V = Volatile Compound

S = Semi Volatile Compound

Table 8

Recovery Factors for Deuterated Semivolatile Standard Spikes

Compound	Sample Well Number						
	523	563	574	575	150	534	516
1-Fluoronapthalene	0.5	0.5	1.0	0.4	0.4	0.4	0.3
d-10 Fluorene	0.5	0.4	0.7	0.6	0.7	0.5	0.2

sediment content samples. The high silt and clay content of most other Sheffield well samples may allow sorbtion of semivolatile compounds to the solids resulting in low spike recovery.

4.0 SUMMARY OF RESULTS

The results of this sampling and analytical program are consistent with the previous study. Dissolved metal concentrations are far below primary drinking water standards. Tritium concentrations in Wells 563 and 575 offsite, and in Well 523 onsite, exceed the primary drinking water standard. The results of organic analyses confirm the conclusion of the previous study that significant organic contamination exists in ground water at the site. In this study, specific EPA listed organic contaminants and other organic compounds have been identified and quantified. Several of the wells (523, 563, 575) contained parts per million concentrations of 1,1,1-trichloroethane and high parts per billion concentration of other volatile organic compounds. These wells are located in close proximity to disposal trenches or in the previously documented seepage plume located east of the disposal site area. Well 516, located at the northern perimeter of the disposal site also contained high volatile solvent concentrations but in proportions slightly different from the previously-mentioned wells. The organic contamination in this well is attributed to sources located outside the Low Level Radioactive Waste Disposal Site. The only EPA listed semivolatile compounds detected were phthalate compounds. Other semivolatile organic compounds including petroleum-derived solvents, fuel hydrocarbons, and petroleum oil were present in most of the samples.

The results of total organic halogen (TOX) analyses performed suggest the presence of compounds which cause interference with the TOX analysis. If further TOX analyses are performed on water samples from this site, the neutron activation analysis method may provide more accurate values than the standard electrolytic conductivity technique.

The results of the quality assurance analyses performed in this study indicate that data reported for metals from samples containing detectable concentrations are typically accurate within 10 to 15%. Quantification of the analytical accuracy for organic compounds is more difficult than for inorganic compounds. The organic QA measures used in this study indicate that results for volatile organic compounds are probably accurate within approximately 50%, which is within the acceptable accuracy range for GC analyses. Results of the deionized water spike analysis for semivolatile compound QA yielded poor results because of a laboratory error in performing the spike. The recovery of deuterated organic compound spikes added to each sample prior to extractions was variable between the seven samples analyzed. The variability in spike recovery is attributed to the presence of silt and clay in the samples which may have sorbed a portion of the organic compounds, and inhibited their extraction.

5.0 COMPARISON OF JANUARY AND SEPTEMBER 1985 WATER ANALYSES

Qualitatively, the results of the two Sheffield data sets are very similar. Comparison of inorganic analytical results for the three wells sampled in both sample trips (563, 574, 575) shows very minor differences in parameter concentrations between the two data sets. Of the additional wells sampled in the September trip (150, 523, 516, and 534), well 523 showed water quality similar to the trench 18 well which was sampled in January, and the others contained concentrations of inorganic constituents similar to the background well.

Results of the organic analyses were also similar between the two sample sets. Differences in the analytical protocols used in analysis of the two sample sets results in detection of slightly different suites of organic compounds in the two data sets. Application of the Method 8600 protocols on the January sample set resulted in detection of several classes of organic compounds. Later analysis of the January sample set resulted in detection of several volatile and semivolatile compounds including chlorinated solvents (trichloroethane, trichloroethylene, tetrachloroethylene), dioxane (a liquid scintillation fluid), several petroleum fuel derived compounds (cyclohexene related compounds) and two high molecular weight compounds. The same principal organic compounds were detected in the September sample set as were detected in the January samples. Differences in the two data sets include detection of dioxane in January but not in September, more accurate quantification of the volatile compounds present in September, and qualitative identification of petroleum hydrocarbons in the September sample set.

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The dioxane was detected as a result of having performed the reverse phase cartride extraction on the January samples. This extraction procedure was not performed on the September data set and the dioxane (a water soluble semivolatile which is not recovered by the extraction procedure used in conjunction with Method 625) was therefore not detected.

REFERENCES

1. Ketelle, R. H., J. T. Kitchings, R. H. Owenby, J. E. Caton, "Results of Reconnaissance Evaluation of Hazardous Chemical Migration in Ground Water in the Vicinity of Two Low-Level Radioactive Waste Disposal Facilities," Contractors Report to the U.S. NRC Low-Level Waste Licensing Branch, Division of Waste Management, Washington, D.C., September 1985.

ATTACHMENT 1

Field Data Logs
September 1985 Sampling Program
Sheffield, Illinois

FIELD DATA LOG

SHEFFIELD, ILLINOIS LLWD SITE

Well 523 Date: 9/19/85

Initial Depth to Water 31.1'
Total Depth 33.8' Casing Stickup 4.1'
Well Diam. 0.42' Surface, 0.25-0.33' Screen
Ft. of Water in Well 2.7'
Estimated Water Vol. in Casing 6.6L

Bails Removed (Liters)	Temp (C)	pH	Specific Conductance µmho/cm	D_o (mg/L)	Redox (mv)
1	17.8	7.2	1510	1.1	
2	15.3	7.2	1370	1.9	
3	14.7	7.2	1330	2.0	
4	14.4	7.1	1240	1.9	
5	14.3	7.1	1310	2.1	
6	14.2	7.0	1310	1.7	126

Well was dry after removing approximately 6L.

FIELD DATA LOG

SHEFFIELD, ILLINOIS LLWD SITE

Well 563   Date: 9/18/85

Initial Depth to Water 41.3'
Total Depth 43.8'   Casing Stickup 3.3'
Well Diam. 0.33'   Vol/foot 0.087 ft^3/ft
Ft. of Water in Well 2.5'
Water Vol. in Casing 6.1L

Bails Removed (Liters)	Temp (C)	pH	Specific Conductance µmho/cm	D_o (mg/L)	Redox (mv)
1	15.2	7.3	670	2.3	
6	13.7	7.2	590	3.1	
10	13.6	7.1	590	3.5	
15	12.0	6.9	660	4.4	
20	13.0	6.9	650	4.9	
22	13.2	6.9	650	5.1	136

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FIELD DATA LOG

SHEFFIELD, ILLINOIS LLWD SITE

Well 574 Date: 9/18/85

Initial Depth to Water 11.75'
Total Depth 19.75'
Well Diam. 0.33'
Ft. of Water in Well 8.0'
Water Vol. in Casing 19.8L

Casing Stickup 2.9'
Vol/foot 0.087 ft^3/ft

Bails Removed (Liters)	Temp (C)	pH	Specific Conductance µmho/cm	D_O (mg/L)	Redox (mv)
1	19.1	8.3	10	1.3	
5	16.9	8.5	60	1.7	
10	15.5	8.4	60	2.2	
15	15.7	8.1	10	2.7	
20	16.2	7.9	30	2.5	
30	15.0	7.7	60	3.7	
40	15.1	7.5	20	3.1	
50	14.5	7.4	270	2.8	
60	14.8	7.5	300	2.6	
65	13.1	7.3	290	2.8	
70	13.5	7.2	280	3.0	193

FIELD DATA LOG

SHEFFIELD, ILLINOIS LLWD SITE

Well 575 Date: 9/18/85

Initial Depth to Water 32.7'
Total Depth 38.9' Casing Stickup 2.8'
Well Diam. 0.33' 0.25' Screen Vol/foot 0.087 ft^3/ft
Ft. of Water in Well 6.2'
Water Vol. in Casing 15.3L

Bails Removed (Liters)	Temp (C)	pH	Specific Conductance µmho/cm	D_O (mg/L)	Redox (mv)
1	13.3	7.2	640	2.2	
10	12.9	7.1	620	3.4	
20	13.0	7.1	650	3.7	
30	12.7	7.1	640	3.7	
40	12.8	7.1	620	3.8	
45	13.0	7.0	630	4.0	
49	12.7	6.9	630	3.7	134

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FIELD DATA LOG

SHEFFIELD, ILLINOIS LLWD SITE

Well 150 Date: 9/18/85

Initial Depth to Water 32.1
Total Depth 57.1'
Casing Diam. 0.2' Vol/foot 0.022 ft^3/ft
Ft. of Water in Well 25'
Water Vol. in Casing 15.5L

Bails Removed (Liters)	Temp (C)	pH	Specific Conductance µmho/cm	D_o (mg/L)	Redox (mv)
1	16.8	7.6	320	0.6	
10	16.6	7.5	260	1.5	
17	18.4	7.6	270	1.1	191

Well bailed dry at 17L removed.

FIELD DATA LOG

SHEFFIELD, ILLINOIS LLWD SITE

Well 534 Date: 9/18/85

Initial Depth to Water 16.1'
Total Depth 27.7' Casing Stickup 0.5'
Well Diam. 0.33' Vol/foot 0.087 ft^3/ft
Ft. of Water in Well 11.6'
Water Vol. in Casing 28.8L

Bails Removed (Liters)	Temp (C)	pH	Specific Conductance µmho/cm	D_O (mg/L)	Redox (mv)
2	17.8	8.2	70	1.6	
15	15.7	8.2	90	2.6	
30	15.4	8.1	110	1.8	115

Well bailed dry at approximately 30L removed.

FIELD DATA LOG

SHEFFIELD, ILLINOIS LLWD SITE

Well 516 Date: 9/18/85

Initial Depth to Water 22.8'
Total Depth 37.9'
Well Diam. 0.42'
Ft. of Water in Well 15.1
Water Vol. in Casing 58.3L

Casing Stickup 4.1'
Vol/foot 0.136 ft^3/ft

Bails Removed (Liters)	Temp (C)	pH	Specific Conductance umho/cm	Do (mg/L)	Redox (mv)
1	14.4	7.6	230	1.0	
10	13.6	7.6	110	2.2	
30	14.9	7.5	150	3.5	
50	13.9	7.5	150	2.0	
70	13.7	7.5	190	3.1	
90	14.5	7.5	210	4.4	
120	16.1	7.5	150	5.0	
140	14.5	7.4	190	2.3	
160	14.8	7.3	180	3.9	
170	14.4	7.3	240	4.4	
176	13.6	7.4	170	2.6	126

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APPENDIX D

BACKGROUND DATA FOR SHEFFIELD SITE

1. Results of USGS sampling on 19 July 1984 at wells 511, 514, 516, 533, 563, and Trench 18
2. Solvents identified in wells upgradient from disposal units by U.S. Ecology
3. Illinois Dept. of Nuclear Safety and Illinois EPA summary and data sheets for organic sampling and analysis, March 1982 - November 1983
4. USGS well construction and stratigraphy diagrams for wells 516, 523, 534, 563, 574, and 575

United States Department of the Interior

GEOLOGICAL SURVEY

WM DOCKET CONTROL
CENTER

'85 JAN 22 P [illegible]

4th Floor
102 East Main Street
Urbana, IL 61801

January 16, 1985

U. S. Nuclear Regulatory Commission
Mail Stop 623-SS
Washington, D.C. 20555
ATTN: Mr. Shaffner

Dear Mr. Shaffner:

Enclosed are results of organic analyses for water samples taken from wells 511, 514, 516, 535, 563, and Trench 18 sump. Samples were collected on July 19, 1984. Of organic compounds analyzed for, above background concentrations were found in wells 516, Trench 18 sump, and 563.

If I can be of further assistance, please call me at FTS 958-5368.

Sincerely yours,

George Garklavs

George Garklavs
Hydrologist

GG:mv
Enclosures
cc: Sherrill

8503010326 850116
PDR ADOCK 02700039
C PDR

157

BEST COPY AVAILABLE

USGS WELL 514

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                                         UNITED STATES DEPARTMENT OF THE INTERIOR
                                                U.S. G   OGICAL SURVEY  WRD
                                             CENTRAL LA   ATORY, ATLANTA, GEORGIA

                               LABORATORY ANALYTICAL SHEET FOR LAB-ID 4229914 RECORD-#  50779

STATION_ID: 412027089473201  COLLECTED-BEGIN DATE 840[illegible] TIME [illegible]30  END DATE      TIME         LAT-LONG-SEC#: ***
NAME: DATA TO BE RETRIEVED FROM HEADER [illegible] COMPLETE   STATE: 17 USER CODE: 17  ILLINOIS                   COUNTY:      G
SAMPLE MEDIUM: 6  STATUS: H  SOURCE:   HYD.CONDITION:     SAMPLE TYPE: 9  HYD.EVENT:      PROJECT/ACCT-#: IL056CO
COMMENTS:
  UNIQUE NUMBER REQUISTED                  SCHEDULES USED 1391   0    0    0      TOTAL PARAMETERS  28
  NOTE:  THIS SAMPLE WAS LOGGED IN AS "X" TYPE DATA AND WILL NOT TRANSFER TO WATSTORE.  "Q" IN COL(51) OF AN "A" C
  PRINTED ON 09/01/84 FIRST RETREIVAL "LABPRIN" 09/01/84   ADD XYLENE - SAMPLE FROM LOW LEVEL RAD SITE

NAME                      RMK/VALUE     UNITS METHOD      W-CODE  LC    NAME                         RMK/VALUE     UNITS  METHOD

ANALYZING AGENCY              80010            -    -         28  191   SP. CONDUCTANCE FLD             8100       UMHOS  I-1780-
BENZENE, TOTAL             <    3.0     UG/L  0-3011-80    34030 1011   TETRACHLOROETHYLEN,T <           3.0       UG/L   0-3011-
BROMOFORM, TOTAL           <    3.0     UG/L  0-3011-80    32104 1012   TOLUENE, TOTAL       <           3.0       UG/L   0-3011-
CARBON TETRA., TOT.        <    3.0     UG/L  0-3011-80    32102 1013   TRICHLOROETHYLENE,T  <           3.0       UG/L   0-3011-
CENTRAL LAB-ID-#            4229914            -    -      99998 1500   TRICHLOROFLUOROMET,T <           3.0       UG/L   0-3011-
CHLOROBENZENE, TOTAL       <    3.0     UG/L  0-3011-80    34301 1014   WATER TEMPERATURE               13.0       DEG C   -     -
CHLORODIBROMO., TOT.       <    3.0     UG/L  0-3011-80    32105 1015   1,1-DICHLORETHYLEN,T <           3.0       UG/L   0-3011-
CHLOROFORM, TOTAL          <    3.0     UG/L  0-3011-80    32106 1018   1,1-DICHLOROETHANE,T <           3.0       UG/L   0-3011-
COLLECTION AGENCY             81700            -    -         27   03   1,1,1-TRICHLOROETH,T <           3.0       UG/L   0-3011-
DICHLOROBROMOMETHA,T       <    3.0     UG/L  0-3011-80    32101 1019   1,1,2-TRICHLOROETH,T <           3.0       UG/L   0-3011-
DICHLORODIFLUOROME,T       <    3.0     UG/L  0-3011-80    34668 1020   1,1,2,2-TETRCHLORO,T <           3.0       UG/L   0-3011-
ETHYLBENZENE, TOTAL        <    3.0     UG/L  0-3011-80    34371 1027   1,2-DICHLOROETHANE,T <           3.0       UG/L   0-3011-
METHYLENE CHLORIDE,T       <    3.0     UG/L  0-3011-80    34423 1029   1,2-DICHLOROPROPAN,T <           3.0       UG/L   0-3011-
PH FIELD                        9.4     UNITS I-1586-77      400   51   12TRANSDICL-ETHYLENE <           3.0       UG/L   0-3011-
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USGS WELL 511

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                                   UNITED STATES DEPARTMENT OF THE INTERIOR
                                        U.S. GEOLO   AL SURVEY  WRD
                                      CENTRAL LABORA   /, ATLANTA, GEORGIA

                           LABORATORY ANALYTICAL SHEET FOR LAB-ID 4229916 RECORD-#  50783

ATION_ID: 412021089473901  COLLECTED:  BEGIN DATE 840719 TIME 0900  END DATE       TIME         LAT-LONG-SEQ#: 412021
ME: SHEFFIELD WELL 511                                STATE: 17 USER CODE: 17  ILLINOIS                  COUNTY: 011 GEO.L
MPLE MEDIUM: 6  STATUS: H  SOURCE:    HYD.CONDITION:     SAMPLE TYPE: 9  HYD.EVENT:    PROJECT/ACCT-#: IL05600    COS
MMENTS:
UNIQUE NUMBER REQUESTED                    SCHEDULES USED 1391    0    0    0     TOTAL PARAMETERS  28
WATSTORE STORAGE REQUESTED.  STATION HEADER DATA WAS SUBSTITUED.  PLEASE CHECK NAME, STATE CODE, COUNTY, AND LAT_LON
PRINTED ON 09/01/86 FIRST RETREIVAL "LABPRIN" 09/01/86   ADD XYLENE - SAMPLE FROM LOW LEVEL RAD SITE.


ME                    RMK/VALUE     UNITS METHOD       W-CODE   LC      NAME                     RMK/VALUE     UNITS METHOD

ALYZING AGENCY           80010               -    -        28   91      SP. CONDUCTANCE FLD        7800        UMHOS I-1780-77
NZENE, TOTAL         <        3.0   UG/L  0-3011-80   34030 1011      TETRACHLOROETHYLEN,T <        3.0     UG/L  0-3011-80
OMOFORM, TOTAL       <        3.0   UG/L  0-3011-80   32104 1012      TOLUENE, TOTAL       <        3.0     UG/L  0-3011-80
RBON TETRA., TOT.    <        3.0   UG/L  0-3011-80   32102 1013      TRICHLOROETHYLENE,T  <        3.0     UG/L  0-3011-80
NTRAL LAB-ID-#         4229916               -    -     99998 1500      TRICHLOROFLUOROMET,T <        3.0     UG/L  0-3011-80
LOROBENZENE, TOTAL   <        3.0   UG/L  0-3011-80   34301 1014      WATER TEMPERATURE           12.0     DEG C  -    -
LORODIBROMO., TOT.   <        3.0   UG/L  0-3011-80   32105 1015      1,1-DICHLORETHYLEN,T <        3.0     UG/L  0-3011-80
LOROFORM, TOTAL      <        3.0   UG/L  0-3011-80   32106 1018      1,1-DICHLOROETHANE,T <        3.0     UG/L  0-3011-80
LLECTION AGENCY          81700               -    -        27   83      1,1,1-TRICHLOROETH,T <        3.0     UG/L  0-3011-80
CHLOROBROMOMETHA,T   <        3.0   UG/L  0-3011-80   32101 1019      1,1,2-TRICHLOROETH,T <        3.0     UG/L  0-3011-80
CHLORODIFLUOROME,T   <        3.0   UG/L  0-3011-80   34668 1020      1,1,2,2-TETRCHLORO,T <        3.0     UG/L  0-3011-80
HYLBENZENE, TOTAL    <        3.0   UG/L  0-3011-80   34371 1027      1,2-DICHLOROETHANE,T <        3.0     UG/L  0-3011-80
THYLENE CHLORIDE,T   <        3.0   UG/L  0-3011-80   34423 1029      1,2-DICHLOROPROPAN,T <        3.0     UG/L  0-3011-80
, FIELD                       7.3   UNITS I-1586-77     400   51      12TRANSDICL-ETHYLENE <        3.0     UG/L  0-3011-80
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USGS well 553

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                                  UNITED STATES DEPARTMENT OF THE INTERIOR
                                         U.S. GEOLOGICAL SURVEY  WRD
                                      CENTRAL LABORATORY, ATLANTA, GEORGIA

                         LABORATORY ANALYTICAL SHEE. FOR LAB-ID 4229917 RECORD-#  50785

STATION_ID: 412025089473601  COLLECTED: BEGIN DATE 840719 TIME 11[illegible] END DATE      TIME        LAT-LONG-SEQ#: ******
NAME: DATA TO BE RETRIEVED FROM HEADER WHEN COMPLETE  STATE: 17 [illegible] CODE: 17  ILLINOIS                 COUNTY:      GEO.
SAMPLE MEDIUM: 6  STATUS: H  SOURCE:    HYD.CONDITION:    SAMPLE TYPE: 9  HYD.EVENT:    PROJECT/ACCT-#: IL05600
COMMENTS:
X UNIQUE NUMBER REQUESTED                  SCHEDULES USED 1391    0    0    0     TOTAL PARAMETERS  28
 NOTE:  THIS SAMPLE WAS LOGGED IN AS "X" TYPE DATA AND WILL NOT TRANSFER TO WATSTORE.  "Q" IN COL(51) OF AN "A" CA
 PRINTED ON 09/01/84 FIRST RETREIVAL "LABPRIN" 08/01/84   ADD XYLENE - SAMPLE FROM LOW LEVEL RAD SITE.

NAME                    RMK/VALUE      UNITS METHOD    WW-CODE   LC    NAME                       RMK/VALUE       UNITS METHOD

ANALYZING AGENCY           80010              -      -      28    91    SP. CONDUCTANCE FLD          3890         UMHOS I-1780-77
BENZENE, TOTAL          <      3.0     UG/L  0-3011-80  34030  1011    TETRACHLOROETHYLEN,T <        3.0         UG/L  0-3011-8
BROMOFORM, TOTAL        <      3.0     UG/L  0-3011-80  32104  1012    TOLUENE, TOTAL       <        3.0         UG/L  0-3011-8
CARBON TETRA., TOT.     <      3.0     UG/L  0-3011-80  32102  1013    TRICHLOROETHYLENE,T  <        3.0         UG/L  0-3011-8
CENTRAL LAB-ID-#         4229917              -      -   99998  1300    TRICHLOROFLUOROMET,T <        3.0         UG/L  0-3011-8
CHLOROBENZENE, TOTAL    <      3.0     UG/L  0-3011-80  34301  1014    WATER TEMPERATURE            13.0         DEG C  -     -
CHLORODIBROMO., TOT.    <      3.0     UG/L  0-3011-80  32105  1015    1,1-DICHLORETHYLEN,T <        3.0         UG/L  0-3011-
CHLOROFORM, TOTAL       <      3.0     UG/L  0-3011-80  32106  1018    1,1-DICHLOROETHANE,T <        3.0         UG/L  0-3011-
COLLECTION AGENCY          81700              -      -      27    83    1,1,1-TRICHLOROETH,T <        3.0         UG/L  0-3011-
DICHLOROBROMOMETHA,T    <      3.0     UG/L  0-3011-80  32101  1019    1,1,2-TRICHLOROETH,T <        3.0         UG/L  0-3011-
DICHLORODIFLUOROME,T    <      3.0     UG/L  0-3011-80  34668  1020    1,1,2,2-TETRACHLORO,T <       3.0         UG/L  0-3011-8
ETHYLBENZENE, TOTAL     <      3.0     UG/L  0-3011-80  34371  1027    1,2-DICHLOROETHANE,T <        3.0         UG/L  0-3011-8
METHYLENE CHLORIDE,T    <      3.0     UG/L  0-3011-80  34423  1029    1,2-DICHLOROPROPAN,T <        3.0         UG/L  0-3011-
PH FIELD                       7.7     UNITS I-1586-77     400    31    12TRANSDICL-ETHYLENE <        3.0         UG/L  0-3011-8
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USGS WELL 535

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                              [illegible]
                          U.S. GEOLOGICAL SURVEY  WRD
                      CENTRAL LABORATORY, ATLANTA, GEORGIA

              LABORATORY ANALYTICAL SH  . FOR LAB-ID 4229918 RECORD-#  50787

STATION_ID: [illegible]  COLLECTED:  BEGIN DATE 840719 TIME 0930  END DATE      TIME        LAT-LONG-SEC#: ****
NAME: DATA TO BE RETRIEVED FROM HEADER WHEN COMPLETE    STATE: 17 USER CODE: 17  ILLINOIS              COUNTY:
SAMPLE MEDIUM: W  STATUS: H  SOURCE:     HYD.CONDITION:     SAMPLE TYPE: 9  HYD.EVENT:     PROJECT/ACCT-#: IL05600
COMMENTS:
  UNIQUE NUMBER REQUESTED                    SCHEDULES USED 1391  50    0    0     TOTAL PARAMETERS  28
  NOTE:  THIS SAMPLE WAS LOGGED IN AS "X" TYPE DATA AND WILL NOT TRANSFER TO WATSTORE.  "0" IN COL(51) OF AN "A" CA
  PRINTED ON 09/01/84 FIRST RETREIVAL "LABPRIN" 09/01/84   RAD XYLENE - SAMPLE FROM LOW LEVEL RAD SITE

NAME                   RMK/VALUE     UNITS METHOD    W-CODE  LC   NAME                     RMK/VALUE     UNITS METHOD

ANALYZING AGENCY         [illegible]             -       28   91   SP. CONDUCTANCE FLD       11000      UMHOS I-1730-
BENZENE, TOTAL         <      3.0    UG/L  0-3011-80  34030 1011   TETRACHLOROETHYLEN,T <      3.0      UG/L  0-3011-
BROMOFORM, TOTAL       <      3.0    UG/L  0-3011-80  32104 1012   TOLUENE, TOTAL       <      3.0      UG/L  0-3011-
CARBON TETRA.., TOT.   <      3.0    UG/L  0-3011-80  32102 1013   TRICHLOROETHYLENE,T  <      3.0      UG/L  0-3011-
CENTRAL LAB-ID-#         4229918             -     99990 1500   TRICHLOROFLUOROMET,T <      3.0      UG/L  0-3011-
CHLOROBENZENE, TOTAL   <      3.0    UG/L  0-3011-80  34301 1014   WATER TEMPERATURE          17.0      DEG C  -    -
CHLORODIBROMO.., TOT.  <      3.0    UG/L  0-3011-80  32105 1015   1,1-DICHLORETHYLEN,T <      3.0      UG/L  0-3011-
CHLOROFORM, TOTAL      <      3.0    UG/L  0-3011-80  32106 1018   1,1-DICHLOROETHANE,T <      3.0      UG/L  0-3011-
COLLECTION AGENCY        81700               -       27   83   1,1,1-TRICHLOROETH,T <      3.0      UG/L  0-3011-
DICHLOROBROMOMETHA,T   <      3.0    UG/L  0-3011-80  32101 1019   1,1,2-TRICHLOROETH,T <      3.0      UG/L  0-3011-
DICHLORODIFLUOROME,T   <      3.0    UG/L  0-3011-80  34668 1020   1,1,2,2-TETRCHLORO,T <      3.0      UG/L  0-3011-
ETHYLBENZENE, TOTAL    <      3.0    UG/L  0-3011-80  34371 1027   1,2-DICHLOROETHANE,T <      3.0      UG/L  0-3011-
METHYLENE CHLORIDE,T   <      3.0    UG/L  0-3011-80  34423 1029   1,2-DICHLOROPROPAN,T <      3.0      UG/L  0-3011-
PH FIELD                      7.8    UNITS I-1586-77    400   51   12TRANSDICL-ETHYLENE <      3.0      UG/L  0-3011-
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                                U.S. GEOLOGICAL SURVEY  WRD
                           CENTRAL LABORATORY, ATLANTA, GEORGIA

                     LABORATORY ANALYTICAL SHEI   OR LAB-ID 4229920 RECORD-#  50791
.TATION_ID: [illegible]        COLLECTED:  BEGIN DATE 840719 TIME 1000  END DATE        TIME         LAT-LONG-SEC#: ******
IAME: DATA TO BE RETRIEVED FROM HEADER WHEN COMPLETE   STATE: 17 USER CODE: 17  ILLINOIS                  COUNTY:      GEO.
AMPLE MEDIUM: 6  STATUS: H  SOURCE:    HYD.CONDITION:    SAMPLE TYPE: 9  HYD.EVENT:    PROJECT/ACCT-#: IL05600     [illegible]
OMMENTS:
 UNICUE NUMBER REQUESTED                   SCHEDULES USED 1391    0    0    0     TOTAL PAR/METEPS  28
 WATSTORE STORAGE WAS REQUESTED.  HEADING INFORMATION COULD NOT BE FOUND.  NO DATA TRANFERRED TO WATSTORE.  PLEASE
 PRINTED ON [illegible]/01/84 FIRST RETREIVAL "LABPRIN" 09/01/84   ADD XYLENE - SAMPLE FROM LOW LEVEL RAD SITE.

IANE                    RMK/VALUE      UNITS METHOD      W-CODE   LC     NAME                    RMK/VALUE      UNITS METHOD

NALYZING AGENCY            80010              -    -        28    91     SP. CONDUCTANCE FLD       13100        UMHOS 1-1780-77
ENZENE, TOTAL         <       3.0      UG/L  0-3011-80   34030  1011     TETRACHLOROETHYLEN,T <       3.0       UG/L  0-3011-80
ROMOFORM, TOTAL       <       3.0      UG/L  0-3011-80   32104  1012     TOLUENE, TOTAL       <       3.0       UG/L  0-3011-80
ARBON TETRA., TOT.    <       3.0      UG/L  0-3011-80   32102  1013     TRICHLOROETHYLENE,T  <       3.0       UG/L  0-3011-80
ENTRAL LAB-ID-#          4229920              -    -     99998  1500     TRICHLOROFLUOROMET,T <       3.0       UG/L  0-3011-80
HLOROBENZENE, TOTAL   <       3.0      UG/L  0-3011-80   34301  1014     WATER TEMPERATURE           16.0       DEG C  -     -
HLORODIBROMO., TOT.   <       3.0      UG/L  0-3011-80   32105  1015     1,1-DICHLORETHYLEN,T <       3.0       UG/L  0-3011-80
HLOROFORM, TOTAL      <       3.0      UG/L  0-3011-80   32106  1018     1,1-DICHLOROETHANE,T          74       UG/L  0-3011-80
OLLECTION AGENCY           81700              -    -        27    83     1,1,1-TRICHLOROETH,T <       3.0       UG/L  0-3011-80
ICHLOROBROMOMETHA,T   <       3.0      UG/L  0-3011-80   32101  1019     1,1,2-TRICHLOROETH,T <       3.0       UG/L  0-3011-80
ICHLORODIFLUOROME,T   <       3.0      UG/L  0-3011-80   34668  1020     1,1,2,2-TETRCHLORO,T <       3.0       UG/L  0-3011-80
THYLBENZENE, TOTAL    <       3.0      UG/L  0-3011-80   34371  1027     1,2-DICHLOROETHANE,T         4.3       UG/L  0-3011-80
ETHYLENE CHLORIDE,T   <       3.0      UG/L  0-3011-80   34423  1029     1,2-DICHLOROPROPAN,T <       3.0       UG/L  0-3011-80
H FIELD                       7.4      UNITS 1-1586-77     400    51     12TRANSDICL-ETHYLENE <       3.0       UG/L  0-3011-80
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BEST COPY AVAILABLE

USGS WELL 563

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                                        U.S. GEOLOGICAL SURVEY  WRD
                                     CENTRAL LABORATORY, ATLANTA, GEORGIA

                         LABORATORY ANALYTICAL SHEL  FOR LAB-ID 4229915 RECORD-#  50781

STATION_ID: 411024089472301  COLLECTED:  BEGIN DATE 840719 TIME 1130  END DATE      TIME        LAT-LONG-SEQ#: ******
NAME: DATA TO BE RETRIEVED FROM HEADER WHEN COMPLETE   STATE: 17 USER CODE: 17  ILLINOIS                 COUNTY:      GEO.
SAMPLE MEDIUM: 6  STATUS: H  SOURCE:     HYD.CONDITION:     SAMPLE TYPE: 9  HYD.EVENT:    PROJECT/ACCT-#: IL05600    CC
COMMENTS:
  UNIQUE NUMBER REQUESTED                        SCHEDULES USED 1391    0    0    0      TOTAL PARAMETERS  28
  NOTE:  THIS SAMPLE WAS LOGGED IN AS "X" TYPE DATA AND WILL NOT TRANSFER TO WATSTORE.  "Q" IN CCL(51) OF AN "A" CARD
  PRINTED ON 09/01/84 FIRST RETREIVAL "LABPRIM" 09/01/84   ADD XYLENE - SAMPLE FROM LOW LEVEL RAD SITE.

NAME                    RMK/VALUE      UNITS METHOD      W-CODE   LC      NAME                          RMK/VALUE      UNITS METHOD

NALYZING AGENCY            80010              -    -         28   .91     SP. CONDUCTANCE FLD            12700          UMHOS I-1780-77
ENZENE, TOTAL         <      3.0      UG/L  0-3011-80    34030  1011      TETRACHLOROETHYLEN,T             62 ✓         UG/L  0-3011-80
ROMOFORM, TOTAL       <      3.0      UG/L  0-3011-80    32104  1012      TOLUENE, TOTAL            <      3.0           UG/L  0-3011-80
ARBON TETRA., TOT.    <      3.0      UG/L  0-3011-80    32102  1013      TRICHLOROETHYLENE,T              4.5 ✓        UG/L  0-3011-80
ENTRAL LAB-ID-#          4229915              -    -      99998  1500      TRICHLOROFLUOROMET,T      <      3.0           UG/L  0-3011-80
HLOROBENZENE, TOTAL   <      3.0      UG/L  0-3011-80    34301  1014      WATER TEMPERATURE               13.0           DEG C  -     -
HLORODIBROMO., TOT.   <      3.0      UG/L  0-3011-80    32105  1015      1,1-DICHLORETHYLEN,T      <      3.0           UG/L  0-3011-80
HLOROFORM, TOTAL             6.2 ✓    UG/L  0-3011-80    32106  1018      1,1-DICHLOROETHANE,T             21 ✓          UG/L  0-3011-80
OLLECTION AGENCY           81700              -    -         27    83     1,1,1-TRICHLOROETH,T      <      3.0           UG/L  0-3011-80
ICHLOROBROMOMETHA,T   <      3.0      UG/L  0-3011-80    32101  1019      1,1,2-TRICHLOROETH,T      <      3.0           UG/L  0-3011-80
ICHLORODIFLUOROME,T   <      3.0      UG/L  0-3011-80    34668  1020      1,1,2,2-TETRCHLORO,T      <      3.0           UG/L  0-3011-80
THYLBENZENE, TOTAL    <      3.0      UG/L  0-3011-80    34371  1027      1,2-DICHLOROETHANE,T             9.0 ✓         UG/L  0-3011-80
ETHYLENE CHLORIDE,T   <      3.0      UG/L  0-3011-80    34423  1029      1,2-DICHLOROPROPAN,T      <      3.0           UG/L  0-3011-80
H FIELD                      6.5      UNITS I-1586-77      400    51      12TRANSDICL-ETHYLENE      <      3.0           UG/L  0-3011-80
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                                          UNITED STATES DEPARTMENT OF THE INTERIOR
                                               U.S. GEOI    CAL SURVEY  WRD
                                            CENTRAL LABOI    RY, ATLANTA, GEORGIA

                              LABORATORY ANALYTICAL SHEET FOR LAB-ID 4229921 RECORD-#  50793

TATION_ID: 413027089472901  COLLECTED:  BEGIN DATE 840719 TIME 0830  END DATE      TIME         LAT-LONG-SEC#: ******
AME: DATA TO BE RETRIEVED FROM HEADER WHEN COMPLETE   STATE: 17 USER CODE: 17  ILLINOIS                 COUNTY:     GEC.
MPLE MEDIUM: 6  STATUS: H  SOURCE:    HYD.CONDITION:     SAMPLE TYPE: 9  HYD.EVENT:     PROJECT/ACCT-#: IL05600    CO
OMMENTS:
 UNIQUE NUMBER REQUESTED                    SCHEDULES USED 1391         0     0     TOTAL PARAMETERS  28
 NOTE:  THIS SAMPLE WAS LOGGED IN AS "X" TYPE DATA AND WILL NOT TRANSFER TO WATSTORE.  "Q" IN COL(51) OF AN "A" CAR
 PRINTED ON 09/01/84 FIRST RETREIVAL "LABPRIN" 09/01/84   ADD XYLENE - SAMPLE FROM LOW LEVEL RAD SITE.

AME                    RMK/VALUE     UNITS METHOD      N-CODE  LC    NAME                     RMK/VALUE     UNITS METHOD

NALYZING AGENCY           80010             -    -        28    91   SP. CONDUCTANCE FLD          7000 ✓     UMHOS I-1780-77
ENZENE, TOTAL          <      3.0     UG/L  0-3011-80  34030  1011   TETRACHLOROETHYLEN,T         1000 ✓     UG/L  0-3011-80
ROMOFORM, TOTAL        <      3.0     UG/L  0-3011-80  32104  1012   TOLUENE, TOTAL          <     3.0      UG/L  0-3011-80
ARBON TETRA., TOT.     <      3.0     UG/L  0-3011-80  32102  1013   TRICHLOROETHYLENE,T          19 ✓      UG/L  0-3011-80
ENTRAL LAB-ID-#         4229921             -    -     99998  1300   TRICHLOROFLUOROMET,T <        3.0      UG/L  0-3011-80
HLOROBENZENE, TOTAL <         3.0     UG/L  0-3011-80  34301  1014   WATER TEMPERATURE            14.0      DEG C  -    -
HLORODIBROMO., TOT. <         3.0     UG/L  0-3011-80  32105  1015   1,1-DICHLORETHYLEN,T          5.5      UG/L  0-3011-80
HLOROFORM, TOTAL            200 ✓     UG/L  0-3011-80  32106  1018   1,1-DICHLOROETHANE,T <        3.0      UG/L  0-3011-80
OLLECTION AGENCY          81700             -    -        27    83   1,1,1-TRICHLOROETH,T <        3.0      UG/L  0-3011-80
ICHLOROBROMOMETHA,T <         3.0     UG/L  0-3011-80  32101  1019   1,1,2-TRICHLOROETH,T <        3.0      UG/L  0-3011-80
ICHLORODIFLUOROME,T <         3.0     UG/L  0-3011-80  34668  1020   1,1,2,2-TETRCHLORO,T <        3.0      UG/L  0-3011-80
THYLBENZENE, TOTAL  <         3.0     UG/L  0-3011-80  34371  1027   1,2-DICHLOROETHANE,T <        3.0      UG/L  0-3011-80
ETHYLENE CHLORIDE,T <         3.0     UG/L  0-3011-80  34423  1029   1,2-DICHLOROPROPAN,T <        3.0      UG/L  0-3011-80
H FIELD                       7.5     UNITS I-1586-77    400    51   12TRANSDICL-ETHYLENE <        3.0      UG/L  0-3011-80
```

USGS WELL 516

164

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US Ecology, Inc.
9200 Shelbyville Road, Suite 526
P.O. Box 7246
Louisville, Kentucky 40207
502 426-7160

WM DOCKET CONTROL
CENTER

'84 AUG 27 P12:08

USEcology

Mr. James Schaffner
U. S. Nuclear Regulatory Commission
Mail Stop MS-623-SS
Washington, DC 20555

August 24, 1984

Dear Mr. Schaffner:

A review of our records on non-radiological data for the Sheffield, Illinois disposal site indicates that the wells monitored are all upgradient from the disposal trenches. Therefore, this data is enclosed for your perusal per your request.

Should you have any questions or desire additional information, please do not hesitate to contact us.

Sincerely,

Elmer D. Martinez
Deputy Chief Radiological
Control and Safety Officer

EDM:db

Enclosures

cc: Ron Gaynor
Vice President Technical
Services and Safety

Ken Waller
Chief Radiological Control
and Safety Officer

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2ND QUARTER SOLVENT ANALYSIS

G-112		Acetone N,N-Dimethylformaline Toluene
G-113		Ethyl Benzene N,N Dimethyl Acetamide N,N Dimethylformamide Methylene Chloride Toluene
G-418		N,N Dimethylformamide Toluene
G-419		Acetone Methylene Chloride Toluene
G-421		N,N Dimethylformamide Toluene
G-422		Toluene
G-423		Toluene
G-424		Toluene
G-425		Toluene
G-426		Toluene
G-427		Toluene
G-428		Methylene Chloride
G-196	'P'	Acetone Toluene
G-197	'O'	Acetone
G-198	'N'	Toulene Trichloroethylene

G-104		Acetone
G-105		None found
G-106		None found
G-107		None found
G-108		Toluene
G-109		None found
G-111		None found
G-114		None found
G-115		None found
G-303		None found
G-199	'C-1'	None found

Organics	Concentration	Location	Date	Detection Limits	Conc. Detected
(1) Methylene Chloride	0.002 ppm	G 199 'C-1'	11/83	<0.001	<1 ppm
	0.001	USGS 515	11/83		
		Old Chemsite			
	0.004 ppm				
(2) 1, 1, 1-trichloroethane	0.006	G196 'P'	11/83	<0.001	<1 ppm
	0.003	G198 'N'	6/83		
	0.032	G198 'N'	7/83		
	0.013	USGS 515	11/83		
	0.003	USGS 516	11/83		
	0.068	USGS 563	11/83		
(3) Trichloroethylene	0.047	G 198 'N'	7/83	<0.001	<1 ppm
	0.020	USGS 516	11/83		
	0.007	USGS 563	11/83		
(4) Perchloroethylene (tetra)	0.011	G 199 'C-1'	11/83		≤1 ppm
	0.002	USGS 514	11/83		
	0.018	USGS 515	11/83		
	1.000	USGS 516	11/83		
	.120	USGS 563	11/83		
(5) Toluene	0.006	G 198 'N'	5/83	<0.005 ppm	<1 ppm
(6) Xylene	0.016	G 196 'N'	5/83	<0.005 ppm	<1 ppm
(7) Acetone	0.012	G 196 'P'	5/83		<1 ppm
	0.162	G 196 'P'	7/83		
	0.003	G 197 'O'	5/83		
	0.432	G 197 'O'	7/83		
(8) Diocytlpthalate	0.240	G 199 'C-1'	3/82		<1 ppm

from Illinois Dept. of Nuclear Safety

D-11

167

Organics	Concentration	Location	Date	Detection Limits	Conc. Detected
(9) Chloroform	0.0002	G 199 'C-1'	11/83	<0.001 ppm	<1 ppm
	0.005	USGS 515	11/83		
	0.180	USGS 516	11/83		
	0.002	USGS 563	11/83		
(10) Dichloroethylene	0.001	G 196 'P'	11/83	<0.001 ppm	<1 ppm
	0.003	USGS 516	11/83		
(11) Carbon tetrachloride	0.004	USGS 516	11/83	<0.001 ppm	<1 ppm
(12) 1, 2-Trichloroethane	0.009	USGS 563	11/83	<0.001 ppm	<1 ppm
(13) PCBs (μg/l)	0.6 = 0.0006 ppm	G 196 'P'	11/83	0.0001 ppm	<1 ppm
	0.54 = 0.00054 ppm	G 196 'O'	3/82		
	3.7 = 00.0037 ppm	G 197 'O'	11/83		
	6.1 = 0.0061 ppm	G 198 'N'	3/82		
	29.0 = 0.029 ppm	G 199 'C-1'	3/82		
	.010 = 0.000010	USGS 519 (new)	11/83		
(14) Trichlorobenzene	0.007	G 199 'C-1'	3/82		
(15) Caprolactam	0.720	G 199 'C-1'	11/83		
(16) 1, 2 Dichloroethane	0.002	USGS 516	11/83	<0.001 ppm	<1 ppm
(17) 1, 1 Dichloro-	0.048	USGS 563	11/83	<0.001 ppm	<1 ppm

Organics	Concentration	Location	Date	Detection Limits	Conc. Detected
(18)Aliphatic Hydrocarbons	0.023	G 198 'N'	3/82		
	0.39	G 199 'C-1'	3/82		
Aliphatic Hydrocarbons	0.100	G 199 'C-1'	11/83		
	0.003	USGS 513	11/83		
	0.003	USGS 513	11/83		<4 ppm
	0.140	USGS 515	11/83		
	0.005	USGS 516	11/83		
	3.900	USGS 519 (new)	11/83		
(19)Unidentified compounds (extractable)	2.100	USGS 519 (new)	11/82		<3 ppm

SHEFFIELD/US ECOLOGY

ORGANICS DETECTED

mostly near old uncontrolled area

OLD CHEM SITE

ppm unless otherwise noted	G196 'P'	G197 'O'	G198 'N'	G199 'C-1'	USGS 511 New Chem	USGS 513 OLD	USGS 514 OLD	USGS 515 OLD	USGS 516 OLD	USGS 519 New	USGS 563
methylene chloride				.002 11/83		silt		.001 11/83	.004 11/83		
1,1,1-trichloroethane	.006 11/83		.003 5/83 .012 7/83			and		.013 11/83	.003 11/83		.040 11/83
trichloroethylene			.047 7/83			clayey			.020 11/83		.007 11/83
perchloroethylene				.011 11/83	Coarse	silt	.002 11/83	.018 11/83	1.000 11/83		.120 11/83
toluene			.006 5/83		grained			fine	coarse		
xylene	.016 5/83							grained	grained		
acetone	.012 5/83 .162 7/83	.003 5/83 .432 7/83			sediment			sediment	sediment		
dioctyl phthalate				.240 3/82						trace 11/83	
chlorophorm				.002 11/83				.005 11/83	.180 11/83		.002 11/83
dichloroethylene	.001 11/83								.003 11/83		
carbon tetrachloride									.004 11/83		
1,2 trichloroethane											.009 11/83
PCBs (ug/l)	0.6 11/83	0.54 3/82 3.7 11/83	6.1 3/82	29.0 3/82						<.010 ? 11/83	
trichlorobenzene				.007 3/82							
caprolactum				.720 11/83							
1,2 dichloroethane									.002 11/83		
1,1 dichloroethane											.048 11/83
aliphatic hydrocarbons			.023 3/82	.037 3/82 .100 11/83	.003 11/83	.003 11/83	.140 11/83	.005 11/83		3.900 11/83	
unidentified compounds (extractables)										2.100 11/83	

570
nothing found

WM Record File

WM Project
Docket No. 27-39
PDR ✓
LPDR ✓

Distribution:
J. Shaffner

(Return to WM, 623-SS)

C!

WM DOCKET CONTROL CENTER

170

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D-14

Sampling Purpose: 04
Program Code: LP41

Time Collected: 10:15 am

Lab # DC31410

SPECIAL ANALYSIS FORM

Date Collected: 11-17-83

Date Received NOV 18 1983

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF LAND/NOISE POLLUTION CONTROL

COUNTY: Bureau	FILE HEADING: Sheffield/US Ecology	FILE NUMBER: 01109503

SOURCE OF SAMPLE: (Exact Location) G196

(2 vials & 1 qt clear glass bottle)

PHYSICAL OBSERVATIONS, REMARKS:

Did not purge well prior to sampling; too slow to recharge
Failed to measure field pH or temperature - not enough water
light brown, silty

TESTS REQUESTED: Volatile organics by purge & trap, EXTRACTABLES - Base-Neutral & acids; include Pesticides (chlorinated hydrocarbons) and PCBs if sufficient water collected

COLLECTED BY: J. STUDENT & J. HOLZER TRANSPORTED BY: JOHN STUDENT

LABORATORY

RECEIVED BY: D. Elenberger DATE COMPLETED: 1/31/84 DATE FORWARDED: 1/31/84

J. Hurley

PCBs = 0.6 ug/l (ppb)

organic compounds not detected in the extracts (Base-Neutral & Acid) of this sample (< 2 ug/l)

Volatile organic compounds dichloroethylene = 1 ug/l
1,1,1-trichloroethane = 6 ug/l

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STATE OF ILLINOIS

DC31410 NOV 18 1983

LPC-8A 4/77

(NOT FOR DATA PROCESSING)

Sampling Purpose: 04
Program Code: LP41

Time Collected: 1:19 pm
Date Collected: 11-17-83

Lab # D031411

SPECIAL ANALYSIS FORM

Date Received NOV 18 1983

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF LAND/NOISE POLLUTION CONTROL

COUNTY: BUREAU	FILE HEADING: SHEFFIELD/US ECOLOGY #2	FILE NUMBER: 01104503

SOURCE OF SAMPLE: (Exact Location) G197 (well O)

(2 vials & 1 gal. glass bottle)

PHYSICAL OBSERVATIONS, REMARKS: Purged 208 gz from well 11:30am on 11-16-83 Field; pH 6.4, temp. 54°F - dark gray, slightly silty used in place bailer for collection

TESTS REQUESTED: Volatile organics by purge & trap, Extractables - Base-Neutrals & Acid fractions including Pesticides (chlorinated hydrocarbons and PCBs

COLLECTED BY: J. STUDENT, J. HOLZER TRANSPORTED BY: J. STUDENT

LABORATORY

RECEIVED BY: D. Ellenberger DATE COMPLETED: 1/31/84 DATE FORWARDED: 1/31/84

PCBs = 3.7 ug/l (PPb)
(Aroclor 1260)

Other Organic compounds not detected in the extracts (<2ug/l
(Base-Neutral + Acid) of this sample.
Volatile organic compounds not detected

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D031411 NOV 18 1983

LPC-8A 4/77 (NOT FOR DATA PROCESSING)

Sampling Purpose: 04
Program Code: LP 41

D031412

Time Collected: 12:40 pm
Lab #
SPECIAL ANALYSIS FORM
Date Collected: 11-17-83
Date Received NOV 18 1983

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF LAND/NOISE POLLUTION CONTROL

COUNTY: Bureau	FILE HEADING: SHEFFIELD/US ECOLOGY #2	FILE NUMBER: 01109503

SOURCE OF SAMPLE: (Exact Location) G-199 (well C-1)

(2 vials & 1 clean qt bottle)

PHYSICAL OBSERVATIONS, REMARKS: Purged 48 g from well 11:15am on 11-16-83
Field: pH 6.6, temp. 54°F – ~~dark~~ brownish, no odor
used in-place copper bailer – insufficient water for larger sample

TESTS REQUESTED: Volatile organics by purge & trap, Extractables – Base-Neutrals & Acid fractions including Pesticides (chlorinated hydrocarbons) and PCBs

COLLECTED BY: J. STUDENT, J. HOLZER TRANSPORTED BY: J. STUDENT

LABORATORY

RECEIVED BY: D. Ellenberger DATE COMPLETED: 1/31/84 DATE FORWARDED: 1/31/84
D Hurley

PCBs = 2.5 ug/l

Caprolactam = 720 ug/l
Aliphatic hydrocarbons = 100 ug/l

Volatile organics
methylene chloride = 2 ug/l
Chloroform = 2 ug/l
tetrachloroethylene = 11 ug/l

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D031412 NOV 18 1983

LPC-8A 4/77 (NOT FOR DATA PROCESSING)

Sampling Purpose: 04
Program Code: LP41

D031413

Time Collected: 3:55 pm

Lab #

SPECIAL ANALYSIS FORM

Date Received NOV 18 1983

Date Collected: 11-17-83

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF LAND/NOISE POLLUTION CONTROL

COUNTY: BUREAU	FILE HEADING: SHEFFIELD/US ECOLOGY #2	FILE NUMBER: 01109503

SOURCE OF SAMPLE: (Exact Location) (US ECOLOGY Well 150) G150

(2 vials & 1 gal glass bottle)

PHYSICAL OBSERVATIONS, REMARKS: Purged 400 gal from well 1:30 pm on 11-16-83
Field: pH 6.6, temp. 54°F — brownish, slightly silty,
no odor — used IEPA teflon bailer for sample collection

TESTS REQUESTED: Volatile organics by purge & trap; Extractables — Base-Neutrals & Acid Fractions including pesticides (chlorinated hydrocarbons) and PCBs

COLLECTED BY: J. STUDENT, ~~[illegible]~~ TRANSPORTED BY: J. STUDENT

LABORATORY

RECEIVED BY: D. Elenberger DATE COMPLETED: 1/31/84 DATE FORWARDED: 1/31/84

PCBs < 0.1 ug/l

organic compounds not detected in the extracts (base-Neutral + acid) of this sample. < 2 ug/l

Volatile organic compounds not detected

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D031413 NOV 18 1983

LPC-8A 4/77 (NOT FOR DATA PROCESSING)

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Sampling Purpose: 04
Program Code: LP 41

Time Collected: 3:30 pm

Lab # D031414

NOV 18 1983

SPECIAL ANALYSIS FORM

Date Collected: 11-17-83

Date Received

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF LAN[illegible]SE POLLUTION CONTROL

COUNTY: BUREAU	FILE HEA[illegible] SHEFFIE[illegible]/US ECOLOGY #2	FILE NUMBER: 01109503

SOURCE OF SAMPLE: (Exact Location) (USGS [illegible]ell 511) G1B1

(2 vials & 1 ga[illegible]ass bottle)

PHYSICAL OBSERVATIONS, REMARKS: Purged 1360 g from well 10:55 am on 11-17-83 Field: pH 7.3, temp. 54°F - dark yellow at top of well to dark grey at bottom of well, pungent, garliclike odor - collected with USGS copper bailer @ well

TESTS REQUESTED: Volatile organics by purge & trap; Extractables - Base-Neutrals & Acid Fractions including pesticides and PCBs

COLLECTED BY: JOHN STUDENT

TRANSPORTED BY: JOHN STUDENT

LABORATORY

RECEIVED BY: D. Ellenberger

DATE COMPLETED: 1/31/84

DATE FORWARDED: 1/31/84

PCBs < 0.1 ug/l

Aliphatic hydrocarbons = 3 ug/l

Volatile organics not detected

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D031414 NOV 18 1983

LPC-8A 4/77

(NOT FOR DATA PROCESSING)

175

Sampling Purpose: 04
Program Code: LP41

Time Collected: 1:05 pm

Date Collected: 11-17-83

Lab # D031415

SPECIAL ANALYSIS FORM

Date Received NOV 18 1983

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF LAND/NOISE POLLUTION CONTROL

COUNTY: BUREAU	FILE HEADING: SHEFFIELD/US ECOLOGY	FILE NUMBER: 01109503

SOURCE OF SAMPLE: (Exact Location) (USGS WELL 513) G1B3

(2 vials & 1 gal glass bottle)

PHYSICAL OBSERVATIONS, REMARKS: Purged 530 gal from well 3:50 pm on 11-16-83 Field: pH 7.2, temp 7.2 Removed Water level recorder for access, used USGS copper bailer for collection, no color, some rust, slight oil like film on top, strong garlic like odor

TESTS REQUESTED: Volatile organics by purge and trap; Extractables: Base-Neutrals & Acid Fractions including chlorinated hydrocarbons and PCB's

COLLECTED BY: J. STUDENT, J. HOLZER TRANSPORTED BY: J. STUDENT

LABORATORY

RECEIVED BY: D. Elenberger DATE COMPLETED: 1/31/84 DATE FORWARDED: 1/31/84

PCBs <0.1 ug/l

Aliphatic hydrocarbons = 3 ug/l

Volatile organics not detected

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D031415 NOV 18 1983

LPC-8A 4/77

(NOT FOR DATA PROCESSING)

Sampling Purpose: 04
Program Code: LP41

Time Collected: 2:25 pm
Lab # D031416

SPECIAL ANALYSIS FORM

Date Collected: 11-17-83
Date Received NOV 18 1983

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF LAND/NOISE POLLUTION CONTROL

COUNTY: BUREAU	FILE HEADING: SHEFFIELD/US ECOLOGY #2	FILE NUMBER: 01109503

SOURCE OF SAMPLE: (Exact Location) (USGS well 514) G1B4

(2 vials and 1 gal. glass bottle)

PHYSICAL OBSERVATIONS, REMARKS: Purged 162 oz from well 2:20 pm on 11-16-83
Field: pH 10.2, temp 54°F – yellow, with rust flakes, fuel like odor
used USGS copper bailer @ well to collect sample

TESTS REQUESTED: Volatile organics by purge and trap; Extractables:
Base-Neutrals and Acid Fractions including chlorinated hydrocarbons
and PCBs

COLLECTED BY: J. STUDENT, ~~J. [illegible]~~ TRANSPORTED BY: J. STUDENT

DAN R. Sammons LABORATORY

RECEIVED BY: DATE COMPLETED: 1/31/84 DATE FORWARDED: 1/31/84

PCBs < 0.1 ug/l

Aliphatic hydrocarbons = 140 ug/l

Tetrachloroethylene = 2 ug/l

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STATE OF ILLINOIS

D031416 NOV 18 1983

LPC-8A 4/77

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Sampling Purpose: U4
Program Code: LP41

Time Collected: 1:40 pm

Lab # D031417

SPECIAL ANALYSIS FORM

Date Collected: 11-17-83

Date Received NOV 18 1983

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF LAND/NOISE POLLUTION CONTROL

COUNTY:	FILE HEADING:	FILE NUMBER:
BUREAU	SHEFFIELD/US ECOLOGY #2	01109503

SOURCE OF SAMPLE: (Exact Location) (USGS WELL 515) G1B5

(2 vials & 1 gal glass bottle)

PHYSICAL OBSERVATIONS, REMARKS: Purged 576 g from well 3:15 pm on 11-16-83 Field: pH 7.6, temp 54°F - brownish green, some oil like film, rust & silt peculiar odor; garliclike - fuel? Used IEPA teflon bailer to collect sample

TESTS REQUESTED: Volatile organics by purge & trap; Extractables Base-Neutrals & Acid Fractions including chlorinated hydrocarbons and PCBs

COLLECTED BY: J. STUDENT, J. HOLZER TRANSPORTED BY: J. STUDENT

LABORATORY

RECEIVED BY: D. Ellenberger DATE COMPLETED: 1/31/84 DATE FORWARDED: 1/31/84

PCBs < 0.1 ug/l

D. Hurley

Aliphatic hydrocarbons = 5 ug/l

Volatile organics chloroform = 5 ug/l
1,1,1-trichloroethane = 13 ug/l
tetrachloroethylene = 18 ug/l
methylene chloride = 1 ug/l

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STATE OF ILLINOIS

D031417 NOV 18 1983

LPC-8A 4/77

(NOT FOR DATA PROCESSING)

Sample Purpose: 04
Program Code: LP41
Time Collected: 2:50 pm
Lab # D031418
SPECIAL ANALYSIS FORM
Date Collected: 11-17-83
Date Received NOV 18 1983

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF LAND/NOISE POLLUTION CONTROL

COUNTY:	FILE HEADING:	FILE NUMBER:
BUREAU	SHEFFIELD/US ECOLOGY #2	01109503

SOURCE OF SAMPLE: (Exact Location) (USGS well 516) G1B6

(2 vials & 1 gal glass bottle)

PHYSICAL OBSERVATIONS, REMARKS: Purged 1444 oz from well ~~at~~ 8:50am on 11-17-83
Field: pH 6.9, temp 54°F - very light yellow cast, no silt but rusty, garliclike odor. Used IEPA teflon bailer to collect sample

TESTS REQUESTED: Volatile organics by purge & trap; Extractables; Acid & Base-Neutral Fractions including chlorinated hydrocarbons and PCBs

COLLECTED BY: JOHN STUDENT TRANSPORTED BY: JOHN STUDENT

LABORATORY

RECEIVED BY: D. Clinebergen DATE COMPLETED: 1/31/84 DATE FORWARDED: 1/31/84 J. Hurley

PCBs < 0.1 ug/l

Extractable organics - Not detected (< 2 ug/l)
(Base-Neut + Acid)

Volatile organics
methylene chloride = 4 ug/l
dichloroethylene = 3 ug/l
Chloroform = 180 ug/l
1,2-dichloroethane = 2 ug/l
1,1,1-trichloroethane = 3 ug/l
Carbon tetrachloride = 4 ug/l
trichloroethylene = 20 ug/l
tetrachloroethylene = 1000 ug/l

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E.P.A. [illegible]
STATE OF ILLINOIS

D031418 NOV 18 1983

LPC-8A 4/77

(NOT FOR DATA PROCESSING)

Sampling Purpose: 04
Program Code: LP41
Time Collected: 3:10 pm
Lab # D031419

SPECIAL ANALYSIS FORM

Date Collected: 11-17-83
Date Received NOV 18 1983

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF LAND/NOISE POLLUTION CONTROL

COUNTY:	FILE HEADING:	FILE NUMBER:
BUREAU	SHEFFIELD/US ECOLOGY #2	01109503

SOURCE OF SAMPLE: (Exact Location) (USGS WELL 519) G1B9

(2 vials & 1 gal. glass bottles)

PHYSICAL OBSERVATIONS, REMARKS: Purged 493 oz from well 9:35 am on 11-17-83 Field: pH 10.5, temp 55°F - all but bottom of well yielded clear water with no odor; last bail had rust, was light brown, some oil sheen diesel fuel like odor. Used IEPA teflon bailer to collect sample

TESTS REQUESTED: Volatile organics by purge and trap; Extractables: Base-Neutrals & Acid Fractions including chlorinated hydrocarbons and PCBs

COLLECTED BY: J. STUDENT & J. HOLZER TRANSPORTED BY: JOHN STUDENT

LABORATORY

RECEIVED BY: D. Clenberger DATE COMPLETED: 1/31/84 DATE FORWARDED: 1/31/84

PCBs - Not detected <10 ug/l (ppb) J. Hurley
Aliphatic hydrocarbons = 3900 ug/l
unidentified compounds estimated to be approx 100 ug/l total (Individual compounds too low for identification)
Volatile organics not detected except for acetone (trace) JH

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STATE OF ILLINOIS

D031419
NOV 18 1983

LPC-8A 4/77
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Sampling Purpose: 04
Program Code: LP41

Time Collected: 5:00 pm

Lab # 033420

SPECIAL ANALYSIS FORM

Date Collected: 11-17-83

Date Received NOV 18 1983

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF LAND/NOISE POLLUTION CONTROL

COUNTY:	FILE HEADING:	FILE NUMBER:
BUREAU	SHEFFIELD/US ECOLOGY #2	01109503

SOURCE OF SAMPLE: (Exact Location) (USGS well 563) G1G3

(2 vials and 1 gal. glass bottle)

PHYSICAL OBSERVATIONS, REMARKS: Purged 430 g. from well 4:20 pm on 11-16-83
Field: pH 6.4, temp 54°F - orange, no silt but flocculated in USGS PVC bailer when 1st pulled from well - strong odor
* Sample collected 6-21-83 by IDNS determined to contain 327±271 pCi/liter Tritium

Note!

TESTS REQUESTED: Volatile organics by purge & trap; Extractables: Base-Neutrals and Acid extractions including chlorinated hydrocarbons and PCBs

COLLECTED BY: J. STUDENI J. HOLZER TRANSPORTED BY: J. STUDENI

LABORATORY

RECEIVED BY: DATE COMPLETED: 1/31/84 DATE FORWARDED: 1/31/84

PCBs < 0.1 ug/l

Extractables - not detected (< 2 ug/l)

Volatile organics
1,1-dichloroethane = 48 ug/l
Chloroform = 2 ug/l
1,1,2-trichloroethane = 9 ug/l
1,1,1-trichloroethane = 68 ug/l
trichloroethylene = 7 ug/l
tetrachloroethylene = 120 ug/l

RECEIVED
FEB 01 1984
[illegible]
STATE OF ILLINOIS

D033420 NOV 18 1983

LPC-SA 4/77

(NOT FOR DATA PROCESSING)

Sampling Purpose: 04
Program Code: LP41

Time Collected: 4:35 pm

Lab # D031421

SPECIAL ANALYSIS FORM

Date Collected: 11-17-83

Date Received NOV 18 1983

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF LAND/NOISE POLLUTION CONTROL

COUNTY: BUREAU	FILE HEADING: SHEFFIELD/US ECOLOGY #2	FILE NUMBER: 01109503

SOURCE OF SAMPLE: (Exact Location) (USGS well 570) G1F0

(2 vials & 1 gal. glass bottle)

PHYSICAL OBSERVATIONS, REMARKS: Purged 5.32 g. from well 4:45 pm on 11-16-83 Field: pH 8.4, temp. 55°F - light milky tan, slightly silty, no odor. Used IEPA teflon bailer to collect

TESTS REQUESTED: Volatile organics by purge & trap; Extractables: Base-Neutrals and Acid fractions including chlorinated hydrocarbons and PCBs

COLLECTED BY: J. STUDENT, J. HOLZER TRANSPORTED BY: J. STUDENT

LABORATORY

RECEIVED BY: D. Ellenberger DATE COMPLETED: 1/31/84 DATE FORWARDED: 1/31/84

Hurley

PCBs < 0.1 µg/l

Extractable organics (base-Neutral + Acid) Not detected

Volatile organics not detected.

RECEIVED
FEB 01 1984
E.P.A. - D.L.P.C.
STATE OF ILLINOIS

D031421 NOV 18 1983

LPC-8A 4/77 (NOT FOR DATA PROCESSING)

Detection limits - Volatile organics

	ug/l (ppb)		
methylene chloride	<1		
1,1-dichloroethane	<1		
t-1,2-dichloroethylene	<1		
chloroform	<1		
1,2-dichloroethane	<1		
1,1,-trichloroethane	<1		
carbon tetrachloride	<1		
dichlorobromomethane	<1		
trichloroethylene	<1		
dibromochloromethane	<1		
bromoform	<1		
tetrachloroethylene	<1		
benzene	<5		
toluene	<5		
xylene	<5		
ethylbenzene	<5		

RECEIVED
FEB 01 1984
E.P.A. — D.L.P.C.
STATE OF ILLINOIS

Samples D031411 to D031421
chlorinated hydrocarbon pesticides not detected in these samples

Parameter	µg/l	Parameter	µg/l
Lindane	<0.01	o,p' -DDE	<0.01
Heptachlor	<0.01	p,p' -DDE	<0.01
Aldrin	<0.01	o,p' -DDD	<0.01
Heptachlor Epoxide	<0.01	p,p' -DDD	<0.01
Alpha Chlordane	<0.01	o,p' -DDT	<0.01
Gamma Chlordane	<0.01	p,p' -DDT	<0.01
Dieldrin	<0.01	Toxaphene	<0.5
Endrin	<0.01	~~Silvex~~	
Methoxychlor	<0.05	~~2,4-D~~	
		PCBs	
		Detection limit for PCBs is 0.1 µg/l	

Laboratory number

EPA Use Only -

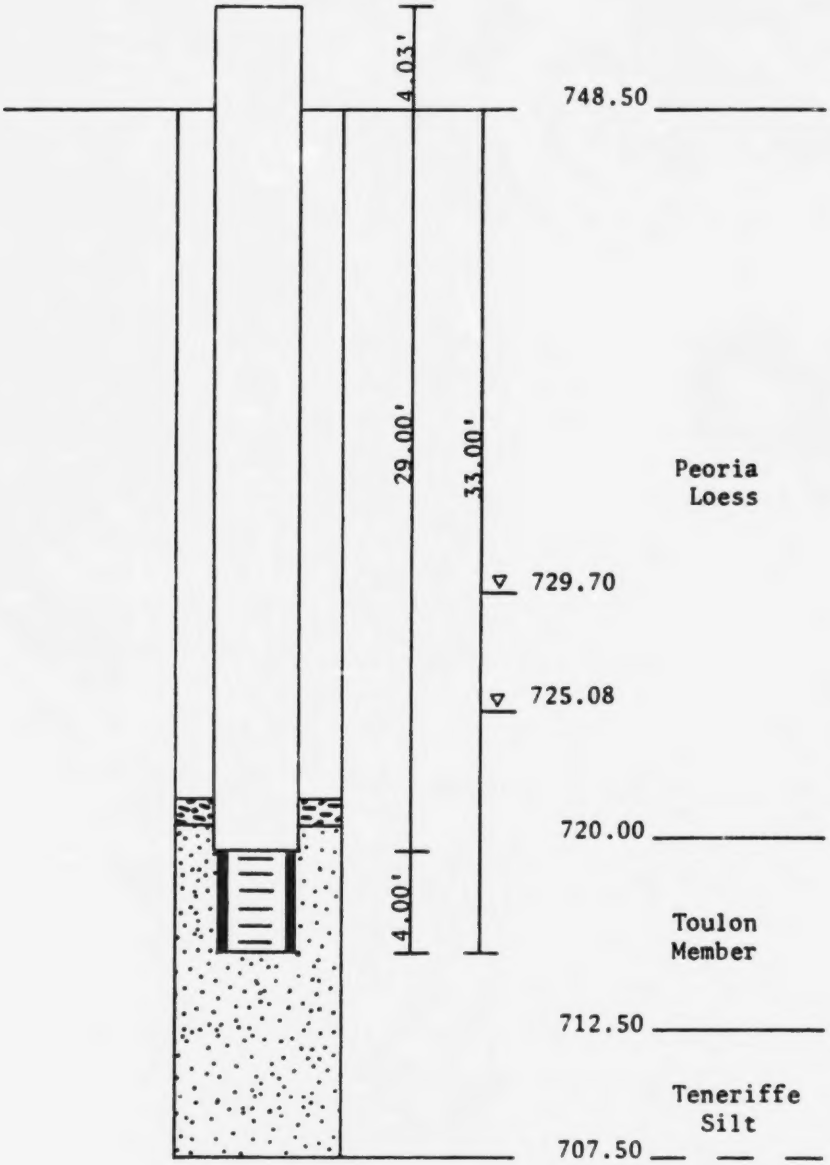
RECEIVED

FEB 01 1984

E.P.A. — D.L.P.C.
STATE OF ILLINOIS

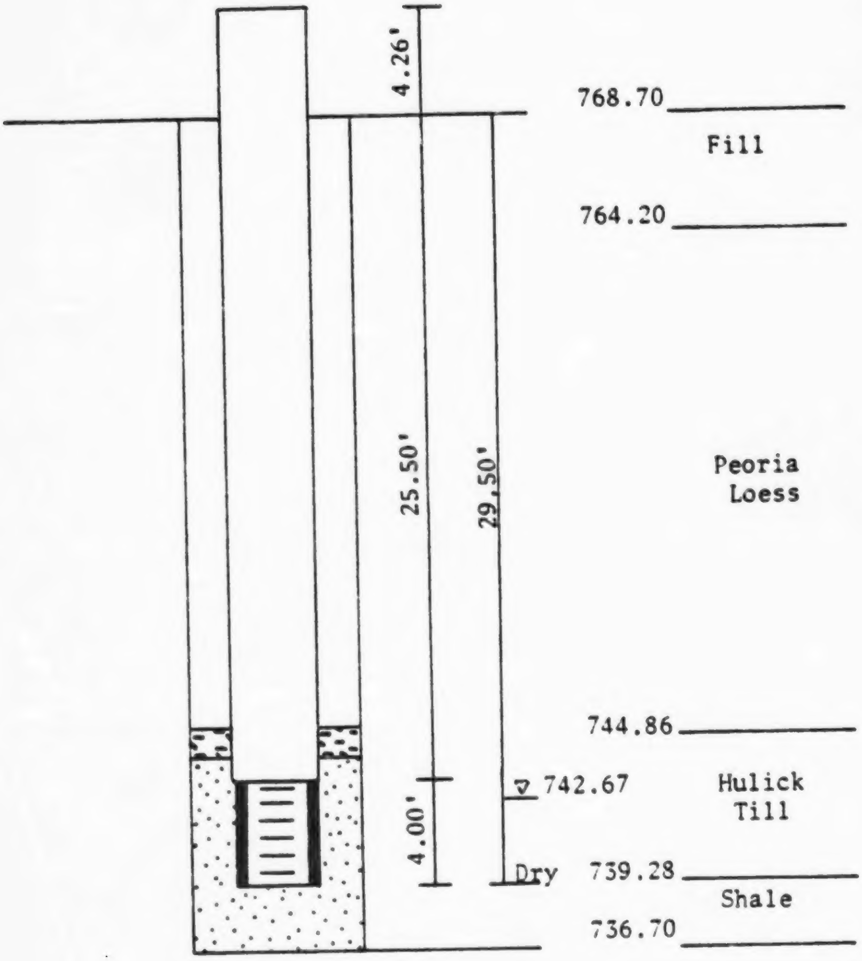
Reported by: Date:

WELL 516
09-02-76

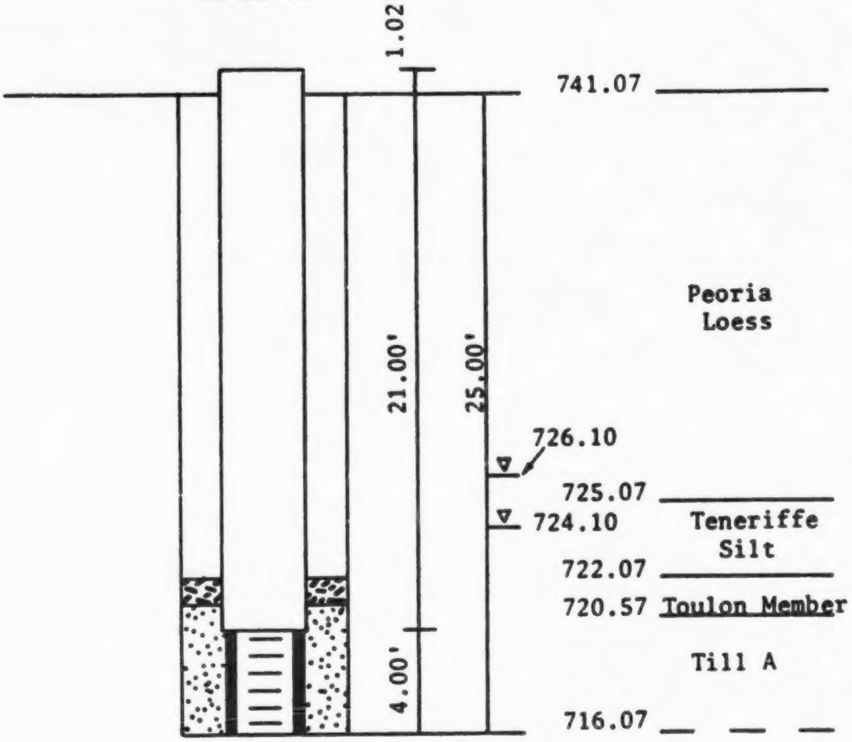

4.03'
748.50
29.00'
33.00'
Peoria Loess
729.70
725.08
720.00
4.00'
Toulon Member
712.50
Teneriffe Silt
707.50

BEST COPY AVAILABLE

WELL 523
09-13-76

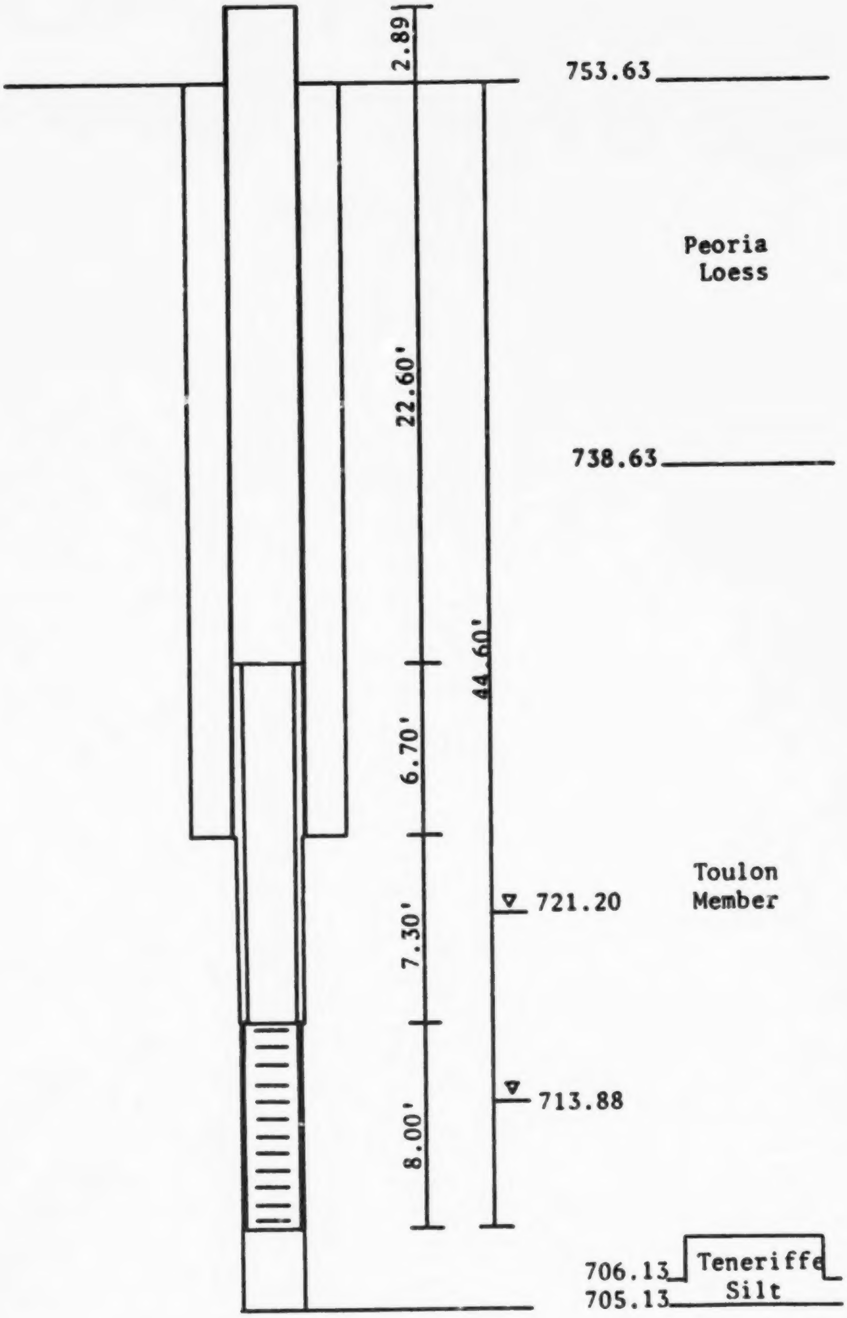

4.26'
768.70
Fill
764.20
25.50'
29.50'
Peoria
Loess
744.86
742.67
Hulick
Till
4.00'
Dry
739.28
Shale
736.70

WELL 534
11-08-78

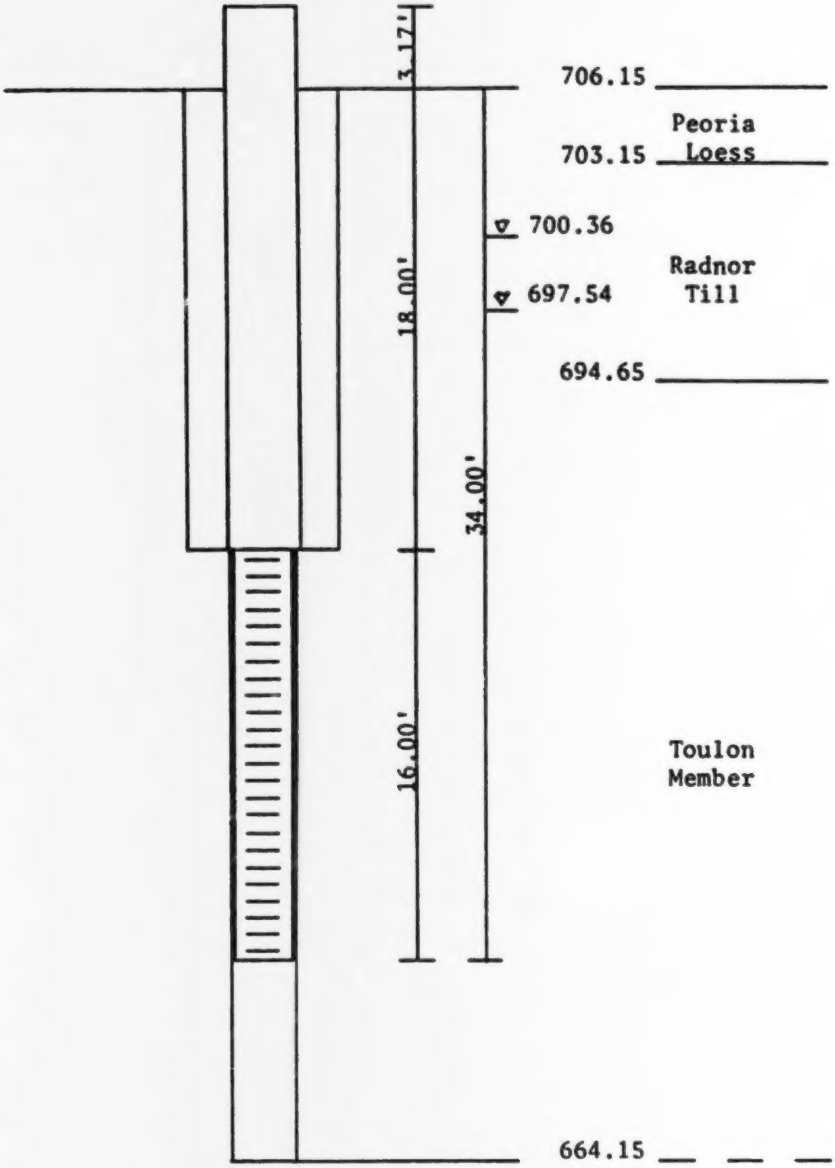

1.02'
741.07
21.00'
25.00'
Peoria Loess
726.10
725.07
724.10
Teneriffe Silt
722.07
720.57
Toulon Member
Till A
4.00'
716.07

187

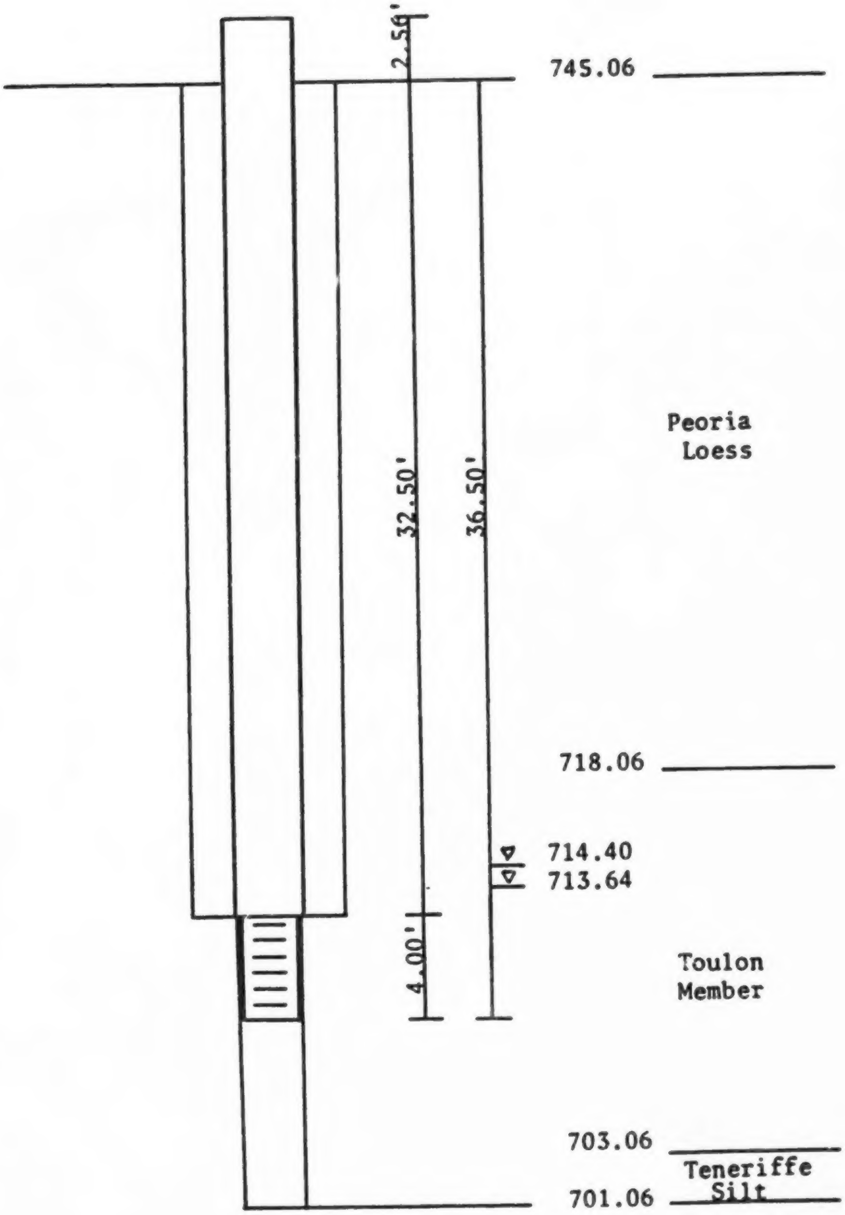
WELL 563
11-17-81


2.89
753.63
Peoria Loess
22.60'
738.63
44.60'
6.70'
Toulon Member
7.30'
721.20
713.88
8.00'
706.13
Teneriffe Silt
705.13

WELL 574
12-17-81


3.17'
706.15
Peoria Loess
703.15
700.36
18.00'
Radnor Till
697.54
694.65
34.00'
16.00'
Toulon Member
664.15

WELL 575
12-23-81


2.50'
745.06
32.50'
36.50'
Peoria Loess
718.06
714.40
713.64
4.00'
Toulon Member
703.06
Teneriffe Silt
701.06

190

APPENDIX E

BACKGROUND DATA FOR BARNWELL SITE

1. Table E-1 Correlation of Barnwell LLW facility well numbers
2. Example well construction diagrams, CNSI wells
3. CNSI non-radiological monitoring report - 1985

TABLE E-1

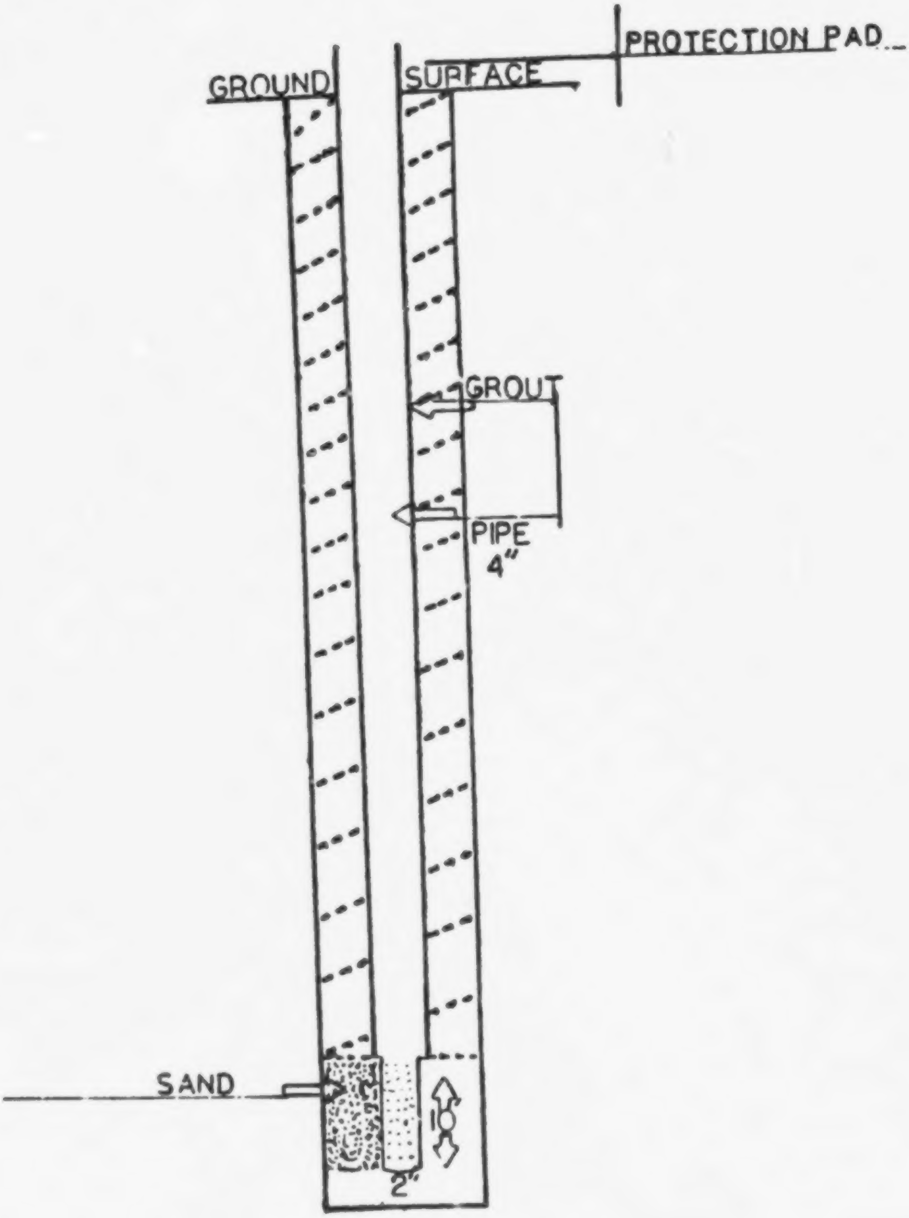
CORRELATION OF BARNWELL LLW FACILITY WELL NUMBERS

CNSI 1985	Cahill 1982*	CNSI 1985	Cahill 1982*
WM-0001	CN-7N	WM-0034	CN-6E
WM-0002	CN-7E	WM-0035	CN-6S
WM-0003	CN-7W	WM-0036	CN-6W
04	B-42	37	CN-5S
05	B-14S	38	CN-5N
06	B-14N	39	CN-4E
07	B-30	40	CN-4W
08	B-20	41	
09	OT-1E	42	
10	OT-1W	43	WW-8
11	C-26	44	WW-5
12	B-25	45	WW-6
13	TW-1 (N or S ?)	46	WW-9
14	CE-7M	47	WW-4
15	CE-7S	48	WW-2W
16	CE-7N	49	WW-7
17	CE-7SS	50	WW-11
18	GS-21	51	WW-13
19	B-18	52	WW-12
20	B-15	53	WW-10
21	CN-1W	54	WW-2E
22	CN-1E	55	WW-1W
23		56	WW-1E
24		57	WW-4E
25	GS-22		
26			
27			
28			
29			
30			
31			
32	CN-2E		
33	CN-2W		

---

* This numbering system was also used by Weiss and Columbo (1980), Czycinski and Weiss (1981), NRC (1982), and previously by CNSI.

DRAWING I


PROTECTION PAD
GROUND SURFACE
GROUT
PIPE
4"
SAND
2"
10'

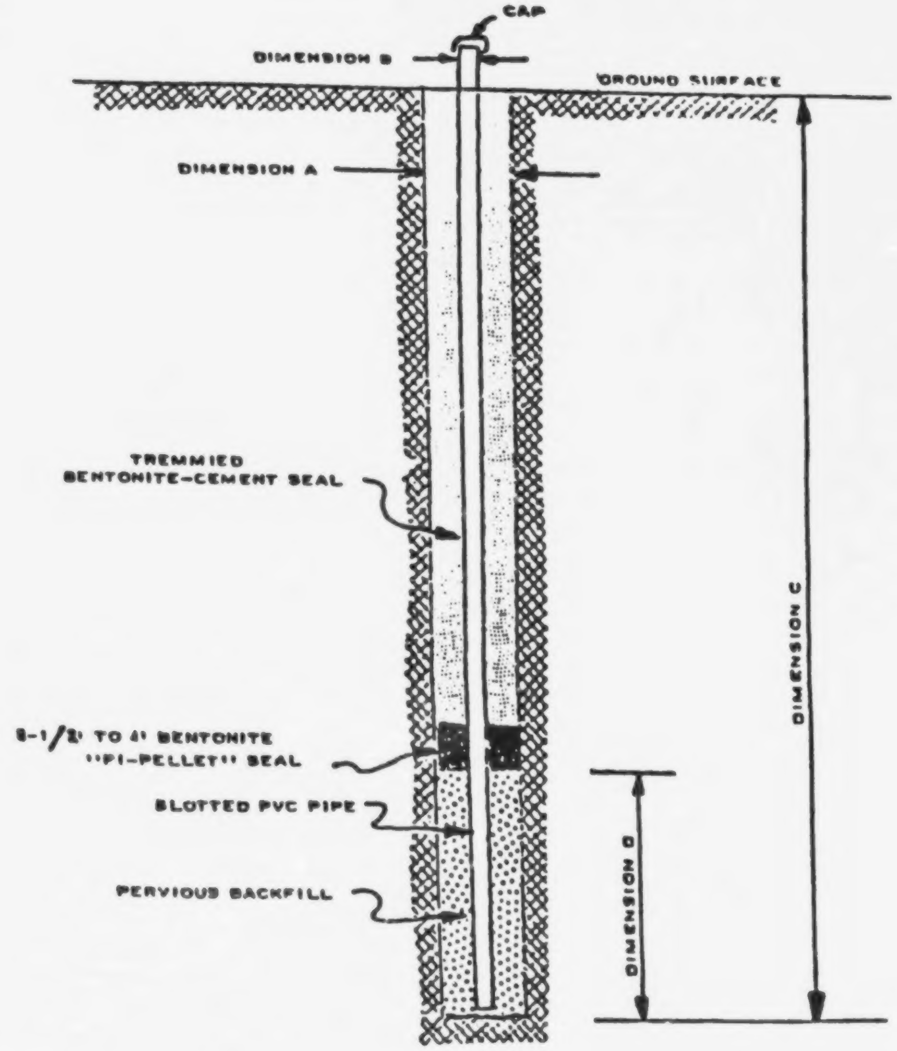
WM-0001 To 03, 21 & 22, WM-0032 to 42
Pipe Casing Diameter 4" Except WM-0021 & 22
which is 3"

WELLS INSTALLED FOR CNSI UNDER THE SUPERVISION OF JIM CAHILL, USGS, AS PART OF A USGS SITE STUDY.

CNSI
ENVIRONMENTAL AND RESEARCH LAB
BARNWELL SITE

DWN BY	DLT	10-01-81	
CKD BY			
APPR'D			

DRAWING II


CAP
DIMENSION B
GROUND SURFACE
DIMENSION A
TREMMIED
BENTONITE-CEMENT SEAL
3-1/2' TO 4' BENTONITE
"PI-PELLET" SEAL
SLOTTED PVC PIPE
PERVIOUS BACKFILL
DIMENSION C
DIMENSION D

TYPICAL PIEZOMETER INSTALLATION
CHEM-NUCLEAR SERVICES, INC.

NOTE: SEE TABLES A AND B FOR DIMENSIONS OF INDIVIDUAL PIEZOMETERS

LAW ENGINEERING TESTING COMPANY
ATLANTA, OCTOBER 1979

NON-RADIOLOGICAL MONITORING REPORT

Non-radiological monitoring of selected site monitoring wells was performed to evaluate present conditions and for the establishment of a routine monitoring program, if determined necessary.

Water samples were collected from strategically located site monitoring wells. These wells include old wells located at the end of completed trenches, and new cluster wells. Specific wells included in this survey are:

WM-0019
WM-0021
WM-0022
WM-0032
WM-0033
WM-0034
WM-0035
WM-0037
WM-0039
WM-0041
WM-0042
WM-0043
WM-0044
WM-0045
WM-0046
WM-0047
WM-0048
WM-0049
WM-0050
WM-0051
WM-0052
WM-0054
WM-0055
WM-0056
WM-0057
WM-0070
WM-0071
WM-0072
WM-0073
WM-0074
WM-0075
WM-0089

Samples were also collected from the deep well at each of the site boundary environmental stations and selected off-site wells to determine a baseline for data review. These consists of the following:

WB-0101
WB-0201
WB-0301
WB-0401
WB-0501
WB-0601
WB-0701
WB-0801
WB-0901
WB-1001
WO-0007
WO-0023
WO-0024
WO-0026
WO-0027
WO-0028
WO-0029
WO-0032

Each sample was collected with a pneumatic water sampler using nitrogen to obtain a sample without the introduction of oxygen into the system. Collection was performed in stages between October 1982 and February 1983. To preserve sample integrity each sample was collected, stored, and shipped on ice. Sample integrity was confirmed by the vendor laboratory as being received in satisfactory condition for analysis. In-situ chemical parameter measurements, performed by CNSI personnel prior to sampling, include temperature, pH, conductance, dissolved oxygen, and oxidation reduction potention (ORP). Duplicate samples were collected for quality assurance measures.

Analyses were performed by EAL Corporation of Richmond, California. Sample analyses include total organic carbon (TOC), total alkalinity, iron, specific solvents, EDTA/DTPA, and priority pollutants. Methods of analysis include gas chromatography and mass spectrometry.

The method used for non-GC/MS volatiles is a GC purge and trap flame ionization detector-method 502 EPA. Variations in results for the GC purge and trap flame ionization versus GC/MS is due to precision and accuracy of the procedures used.

Data are summarized in Attachments 1 and 2. Attachment 1 lists data for the baseline determinations. Attachment 2 lists data for total volatile organics with the specific organic constituents Benzene, Toluene, and Xylene. A review of this data shows a difference between the total volatile organics and the sum of the specific organic analysis.

ATTACHMENT 1

ANALYSIS SUMMARY

NON-RADIOLOGICAL MONITORING OF SELECTED WB AND WO WELLS

ANALYSIS	UNITS	NO. OF SAMPLES ANALYZED	NO. OF ANALYSIS BELOW DETECTION LIMIT	DETECTION LIMIT	POSITIVE VALUES		
					LOW	HIGH	AVERAGE
FERROUS IRON	mg/l	18	17	<0.01	0.01	0.01	0.01
IRON	mg/l	18	10	<0.1	0.1	6.1	1.4
ALKALINITY,							
HYDROXIDE	mgCaCo$_3$/l	18	17	<2	28	28	28
BICARBONATE	mgCaCo$_3$/l	18	6	<2	2	59	21.3
CARBONATE	mgCaCo$_3$/l	18	16	<2	38	85	42.5
TOTAL ORGANIC							
CARBON	mg/l	18	1	<1	1	5	2.5
ACETONE	ug/l	18	10	<1	2	5	3.3
BENZENE	ug/l	18	18	<1	-	-	---
TOLUENE	ug/l	18	6	<1	1	11	4.1

SAMPLE POINTS INCLUDED IN THIS SUMMARY ARE: WB-0101, WB-0201, WB-0301, WB-0401, WB-0501, WB-0601, WB-0701, WB-0801, WB-0901, WB-1001, WO-0007, WO-0023, WO-0024, WO-0026, WO-0027, WO-0028, WO-0029, and WO-0032

TOTALS FOR ALKALINITY AND VOLATILE ORGANICS ARE NOT INCLUDED IN THIS SUMMARY. THIS DATA SHOULD BE REVIEWED FOR A SPECIFIC SAMPLE POINT.

ATTACHMENT 2

ANALYSIS SUMMARY
NON-RADIOLOGICAL MONITORING OF SELECTED WM WELLS

	ANALYSIS (ug/l)			
SAMPLE POINT	BENZENE	TOLUENE	XYLENE	TOTAL VOLATILE ORGANICS
WM-0019	8	<1	<1	32
WM-0021	<1	13	<1	30
WM-0022	<1	2	--	92
WM-0032	<1	2	<1	4
WM-0033	<1	2	2	13
WM-0034	1	7	11	33
WM-0035	<1	70	124	--
WM-0037	--	<1	3	--
WM-0039	8	<1	1	100
WM-0041	2	<1	1	8
WM-0042	<1	<1	<1	6
WM-0043	<1	<1	4	100
WM-0044	3	1	2	60
WM-0045	<1	1	2	22
WM-0046	<1	<1	2	8
WM-0047	<1	<1	2	14
WM-0048	--	1	1	--
WM-0049	--	--	--	--
WM-0050	<1	<1	2	91
WM-0051	1	<1	<1	5
WM-0052	<1	3	<1	20
WM-0054	<1	<1	5	430
WM-0055	<1	5	2	9
WM-0056	<1	8	1	35
WM-0057	<1	<1	<1	14
WM-0070	<1	1	<1	6
WM-0071	<1	1	<1	4
WM-0072	<1	<1	<1	<1
WM-0073	1	2	<1	3
WM-0074	<1	2	<1	26
WM-0075	<1	<1	<1	20
WM-0089	<1	1	<1	40

1984

NON-RADIOLOGICAL MONITORING DATA

SELECTED WM, WB, AND WO WELLS WITH TRITIUM RESULTS

WM-0019

Alkalinity Hydroxide	< 1 mgCaCO$_3$/L
Alkalinity Bicarbonate	< 1 mgCaCO$_3$/L
Alkalinity Carbonate	< 1 mgCaCO$_3$/L
Total Iron	<0.1 mg/L
Ferrous Iron	<0.2 mg/L
TOC	3 mg/L
TVO	32 ug/L
Acetone	< 20 ug/L
1,1,1, Trichloroethane	13 ug/L
Benzene	8 ug/L
Toluene	< 1 ug/L
Xylene	< 1 ug/L
Isopropanol	< 20 ug/L
Ethlbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	5.75+0.20E+03 pCi/l
EDTA	< 2 mg/L
DTPA	< 5 mg/L

WM-0019

VOLATILES-GC/MS	PER ug/L (ppb)
Acrolein	<1
Acrylonitrile	<1
Benzene	5
Carbontetrachloride	<1
Chlorobenzene	<1
1,2-Dichloroethane	10
1,1,1 Trichloroethane	8
1,1-Dichloroethane	<1
1,1,2-Trichloroethane	<1
1,1,2,2-Tetrachloroethane	<1
Chloroethane	<1
2-Chloroethylvinyl Ether	<1
Chloroform	30
1,1-Dichloroethylene	<1
1,2-Trans-Dichloroethylene	<1
1,2-Dichloropropane	<1
1,3-Dichloropropylene	<1
Ethylbenzene	<1
Methylene Chloride	<1
Methyl Bromide	<1
Bromoform	<1
Dichlorobromomethane	<1
Trichlorofluoromethane	10
Dichlorodifluoromethane	<1
Chlorodibromomethane	<1
Tetrachloroethylene	1.4
Toluene	1
Trichloroethylene	<1
Vinyl Chloride	<1

WM-0019 (Continued)

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	20.3	4.9	+382	58	10	--
9/13/82	18.2	4.0	+435	25	14	4.5

WM-0021

Alkalinity Hydroxide		20 mgCaCO$_3$/L
Alkalinity Bicarbonate	<	1 mgCaCO$_3$/L
Alkalinity Carbonate		180 mgCaCO$_3$/L
Total Iron		45 mg/L
Ferrous Iron		0.6 mg/L
TOC		7 mg/L
TVO		30 ug/L
Acetone	<	20 ug/L
1,1,1 Trichloroethane	<	1 ug/L
Benzene	<	1 ug/L
Toluene		13 ug/L
Xylene	<	1 ug/L
Isopropanol	<	20 ug/L
Ethylbenzene	<	1 ug/L
Dichloroethylene	<	1 ug/L
Tritium		$5.21 \pm 0.32E+02$ pCi/L
EDTA		<2 mg/L
DTPA		<5 mg/L

WM-0021

VOLATILES-GC/MC	PER ug/L (ppb)
Acrolein	<1
Acrylonitrile	<1
Benzene	<1
Carbontetrachloride	<1
Chlorobenzene	<1
1,2-Dichloroethane	<1
1,1,1-Trichloroethane	<1
1,1-Dichloroethane	<1
1,1,2-Trichloroethane	<1
1,1,2,2-Tetrachloroethane	<1
Chloroethane	<1
2-Chloroethylvinyl Ether	<1
Chloroform	<1
1,1-Dichloroethylene	<1
1,2-Trans-Dichloroethylene	<1
1,2-Dichloropropane	<1

COPY

WM-0021 (Continued)

1,3-Dichloropropylene	<1
Ethylbenzene	<1
Methylene Chloride	<1
Methyl Chloride	<1
Methyl Bromide	<1
Bromoform	<1
Dichlorobromomethane	<1
Trichlorofluoromethane	<1

VOLATILES-GC/MC	PER ug/L (ppb)
Chlorodibromomethane	<1
Tetrachloroethylene	<1
Toluene	19
Trichloroethylene	<1
Vinyl Chloride	<1

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.9	11.4	+137	619	175	6.0
9/13/82	20.5	10.3	+186	488	210	5.5

WM-0022

Ferrous Iron	<0.01	mg/L
Iron	< 0.1	mg/L
Alkalinity, Hydroxide	< 2	mgCaCO$_3$/L
Alkalinity, Bicarbonate	35	mgCaCO$_3$/L
Alkalinity, Carbonate	< 2	mgCaCO$_3$/L
Alkalinity, Total	35	mgCaCO$_3$/L
TOC	20	mg/L
Acetone	< 8	ug/L
Benzene	< 1	ug/L
Toluene	2	ug/L
TVO	92	ug/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
3/7/83	18.0	5.7	+247	151	95	9.6

COPY

WM-0032

Alkalinity Hydroxide	69 mgCaCO_3/L
Alkalinity Bicarbonate	< 1 mgCaCO_3/L
Alkalinity Carbonate	48 mgCaCO_3/L
Total Iron	< 0.1 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	< 1 mg/L
TVO	4 ug/L
Acetone	< 20 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	2 ug/L
Xylene	< 1 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	7.25±0.43E+02 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.5	9.7	+167	281	--	6.4
9/13/82	18.9	10.0	+ 89	336	85	6.6

WM-0033

Alkalinity Hydroxide	< 1 mgCaCO_3/L
Alkalinity Bicarbonate	60 mgCaCO_3/L
Alkalinity Carbonate	< 1 mgCaCO_3/L
Total Iron	1 mg/L
Ferrous Iron	1 mg/L
TOC	12 mg/L
TVO	13 ug/L
Acetone	5 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	2 ug/L
Xylene	2 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	1.27±0.068E+03 pCi/L

COPY

WM-0033 (Continued)

EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.2	7.8	+215	132	58	7.6
9/13/82	18.9	6.8	+171	162	100	3.6

WM-0034

Alkalinity Hydroxide	1500 mg$CaCO_3$/L
Alkalinity Bicarbonate	< 1 mg$CaCO_3$/L
Alkalinity Carbonate	280 mg$CaCO_3$/L
Total Iron	< 0.1 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	7 mg/L
TVO	33 ug/L
Acetone	< 20 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	1 ug/L
Toluene	7 ug/L
Xylene	11 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	2 ug/L
Dichloroethylene	< 1 ug/L
Tritium	4.68±0.29E+02 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L
TOC	3 mg/L
Solvents	150 ug/L
Acetone	65 ug/L
Isopropanol	< 20 ug/L
Chloroform	2 ug/L
1,2-Dichloroethane	51 ug/L
Toluene	< 1 ug/L
Xylene	3 ug/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.5	10.9	- 90	1025	4500	6.4
9/13/82	19.5	10.9	+158	8180	5000	2.9

203

WM-0035 (Collected 7/12/84)

Alkalinity Hydroxide	< 2 $mgCaCO_3/L$
Alkalinity Bicarbonate	8.3 $mgCaCO_3/L$
Alkalinity Carbonate	< 2 $mgCaCO_3/L$
Iron	58 mg/L
TOC	29 mg/L
Alkalinity Total	8.3 $mgCaCO_3/L$

WM-0035 PRIORITY POLLUTANT DATA

VOLATILES ug/L(ppb)	Per ug/L(ppb)
Acrolein	<20
Acrylonitrile	<20
Benzene	<1
Carbon Tetrachloride	<1
Chlorobenzene	<1
1,2 Dichloroethane	<2
1,1,1 Trichloroethane	<1
1,1 Dichloroethane	<1
1,1,2 Trichloroethane	<1
1,1,2,1 Tetrachloroethane	<1
Chloroethane	<1
2 Chloroethylvinyl ether	<1
Chloroform	<1
1,1 Dichloroethene	<1
Trans 1,2 Dichloroethene	<1
1,2 Dichloropropane	<1
Trans 1,3Dichloropropene	<1
Cis 1,3 Dichloropropene	<1
Ethylbenzene	11
Methylene Chloride	<1
Chloromethane	<1
Bromomethane	<1
Bromoform	<1
Bromodichloromethane	<1
Fluorotrichloromethane	<1
Dichlorodifluoromethane	<1
Chlorodibromomethane	<1
Tetrachloroethene	<1
Toluene	70
Trichloroethene	<1
Vinyl Chloride	<1

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WM-0035 (Cont.)

NON-PRIORITY POLLUTANT DATA

Carbon Disulfide	<1
4 Methyl 2 Pentanone	<10
Styrene	<1
Vinyl Acetate	<2
Butane	*160
2 Methylbutane	*580
Pentane	*180
Methylcyclopentane	*120
2,2 Dimethylbutane	*120
Acetone	<10
2 Butanone	<20
2 Hexanone	<10
Xylenes	124
2 Methylpentane	*420
Hexane	*180
3 Methylhexane	*340
Heptane	*200
2,5 Dimethylheptane	*620

*Estimated concentration. This mixture is similar to gasoline.

WM-0037

Alkalinity Hydroxide	< 1 mgCaCO$_3$/L
Alkalinity Bicarbonate	< 1 mgCaCO$_3$/L
Alkalinity Carbonate	< 1 mgCaCO$_3$/L
Total Iron	< 0.2 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	--
TVO	--
Acetone	--
1,1,1 Trichloroethane	--
Benzene	--
Toluene	--
Xylene	--
Isopropanol	--
Ethylbenzene	--
Dichloroethylene	--
Tritium	3.77±0.24E+02 pCi/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.5	4.2	+292	96	10	12.5
9/13/82	19.2	4.5	+509	14	12	4.5

205

WM-0039

Alkalinity Hydroxide	< 1 mgCaCO$_3$/L
Alkalinity Bicarbonate	33 mgCaCO$_3$/L
Alkalinity Carbonate	< 1 mgCaCO$_3$/L
Total Iron	4.3 mg/L
Ferrous Iron	0.9 mg/L
TOC	5 mg/L
TVO	100 ug/L
Acetone	77 ug/L
1,1,1 Trichloroethane	4 ug/L
Benzene	8 ug/L
Toluene	< 1 ug/L
Xylene	1 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	$2.84 \pm 0.028E+05$ pCi/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	20.3	5.2	+390	57	17	5.2
9/13/82	19.5	5.2	+298	22	19	

WM-0041

Alkalinity Hydroxide	34 mgCaCO$_3$/L
Alkalinity Bicarbonate	< 1 mgCaCO$_3$/L
Alkalinity Carbonate	47 mgCaCO$_3$/L
Total Iron	0.63 mg/L
Ferrous Iron	<0.2 mg/L
TOC	8 mg/L
TVO	8 ug/L
Acetone	< 20 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	2 ug/L
Toluene	< 1 ug/L
Xylene	1 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	$3.73 \pm 0.15E+03$ pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	20.1	10.3	+151	1182	210	4.1
9/13/82	19.4	10.1	+146	386	90	53.0

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WM-0042

Alkalinity Hydroxide	< 1 mgCaCO$_3$/L
Alkalinity Bicarbonate	5 mgCaCO$_3$/L
Alkalinity Carbonate	< 1 mgCaCO$_3$/L
Total Iron	< 0.2 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	2 mg/L
TVO	6 ug/L
Acetone	< 20 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	< 1 ug/L
Xylene	< 1 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	1.36±0.072E+03 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.9	6.3	+258	41	1.3	8.5
9/13/82	19.6	4.9	+382	16	13.0	8.6

WM-0043

Alkalinity Hydroxide	< 1 mgCaCO$_3$/L
Alkalinity Bicarbonate	4 mgCaCO$_3$/L
Alkalinity Carbonate	< 1 mgCaCO$_3$/L
Total Iron	0.60 mg/L
Ferrous Iron	0.26 mg/L
TOC	7 mg/L
TVO	110 ug/L
Acetone	37 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	< 1 ug/L
Xylene	4 ug/L
Isopropanol	39 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	1.21±0.065E+03 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	20.6	5.3	+134	49	14	7.1
9/13/82	19.5	4.8	+372	15	12	6.6

WM-0044

Alkalinity Hydroxide	< 1 mg$CaCO_3$/L
Alkalinity Bicarbonate	4 mg$CaCO_3$/L
Alkalinity Carbonate	< 1 mg$CaCO_3$/L
Total Iron	< 0.2 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	2 mg/L
TVO	60 ug/L
Acetone	13 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	3 ug/L
Toluene	1 ug/L
Xylene	2 ug/L
Isopropanol	16 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	1.06±0.060E+03 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	21.2	8.5	+190	39	11	3.9
9/13/82	20.0	8.6	+191	16	11	2.5

WM-0045

Alkalinity Hydroxide	< 1 $CaCO_3$/L
Alkalinity Bicarbonate	3 $CaCO_3$/L
Alkalinity Carbonate	< 1 $CaCO_3$/L
Total Iron	< 0.2 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	2 mg/L
TVO	22 ug/L
Acetone	6 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	1 ug/L
Xylene	2 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	8.78±0.51E+02 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	20.7	5.2	+362	44	14	6.0
9/13/82	20.0	5.3	+278	14	11	5.7

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WM-0046

Alkalinity Hydroxide	< 1 mg$CaCO_3$/L
Alkalinity Bicarbonate	< 1 mg$CaCO_3$/L
Alkalinity Carbonate	< 1 mg$CaCO_3$/L
Total Iron	2.4 mg/L
Ferrous Iron	0.3 mg/L
TOC	2 mg/L
TVO	8 ug/L
Acetone	< 20 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	< 1 ug/L
Xylene	2 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	2.38±0.11E+03 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.5	4.8	+383	19	10	6.0
9/13/82	20.4	4.9	+328	12	8	6.6

WM-0047

Alkalinity Hydroxide	< 1 mg$CaCO_3$/L
Alkalinity Bicarbonate	27 mg$CaCO_3$/L
Alkalinity Carbonate	< 1 mg$CaCO_3$/L
Total Iron	< 0.2 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	2 mg/L
TVO	14 ug/L
Acetone	< 10 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	< 1 ug/L
Xylene	2 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	20.0	5.8	+377	87	34	4.6
9/13/82	20.2	5.8	+323	60	32	4.4

WM-0048

Alkalinity Hydroxide	< 1 mg$CaCO_3$/L
Alkalinity Bicarbonate	11 mg$CaCO_3$/L
Alkalinity Carbonate	< 1 mg$CaCO_3$/L
Total Iron	< 0.2 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	2 mg/L
Solvents (TVO)	120 ug/L
Acetone	17 ug/L
Isopropanol	74 ug/L
Chloroform	< 1 ug/L
1,2-dichloroethane	23 ug/L
Toluene	1 ug/L
Xylene	1 ug/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.7	5.8	+364	31	15	5.1
9/13/82	19.9	6.2	+294	28	18	3.7

WM-0049

Alkalinity Hydroxide	< 1 mg$CaCO_3$/L
Alkalinity Bicarbonate	6 mg$CaCO_3$/L
Alkalinity Carbonate	< 1 mg$CaCO_3$/L
Total Iron	< 0.2 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	4 mg/L
TVO	91 ug/L
Acetone	7 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Xylene	2 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	1.94±0.10E+03 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L
Tritium	1.11±0.029E+04

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.8	5.6	+373	66	25	5.4
9/13/82	19.0	4.9	+347	20	--	5.3

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WM-0050

Alkalinity Hydroxide	< 1 $mgCaCO_3/L$
Alkalinity Bicarbonate	< 1 $mgCaCO_3/L$
Alkalinity Carbonate	< 1 $mgCaCO_3/L$
Total Iron	0.8 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	4 mg/L
TVO	91 ug/L
Acetone	7 ug/L
1,1,1, Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	< 1 ug/L
Xylene	2 ug/L
Isopropanol	< 20 ug/L
Ethylbanzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	2.94±0.13E+03 pCi/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.3	4.4	+442	43	18	4.5
9/13/82	18.6	4.5	+323	--	18	4.2

WM-0051

Alkalinity Hydroxide	< 1 $mgCaCO_3/L$
Alkalinity Bicarbonate	< 1 $mgCaCO_3/L$
Alkalinity Carbonate	< 1 $mgCaCO_3/L$
Total Iron	0.77 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	4 mg/L
TVO	5 ug/L
Acetone	< 21 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	1 ug/L
Toluene	< 1 ug/L
Xylene	< 1 ug/L
Isopropanol	< 20 ug/L
Dichloroethylene	< 1 ug/L
Tritium	5.84±0.36E+02 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.9	4.2	+419	24	11	9.2
9/13/82	19.9	4.5	+510	34	11	7.6

WM-0052

Alkalinity Hydroxide	< 1 mg$CaCO_3$/L
Alkalinity Bicarbonate	< 1 mg$CaCO_3$/L
Alkalinity Carbonate	< 1 mg$CaCO_3$/L
Total Iron	1 mg/L
Ferrous Iron	1 mg/L
TOC	2 mg/L
TVO	20 ug/L
Acetone	4 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	3 ug/L
Xylene	< 1 ug/L
Isopropanol	13 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
EDTA	<2 mg/L
DTPA	<5 mg/L
Tritium	3.34±0.22E+02 pCi/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.8	5.5	+305	18	7.5	5.3
9/13/82	19.5	4.3	+348	6	6.0	6.6

WM-0054

Alkalinity Hydroxide	< 1 mg$CaCO_3$/L
Alkalinity Bicarbonate	110 mg$CaCO_3$/L
Alkalinity Carbonate	< 1 mg$CaCO_3$/L
Total Iron	1 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	15 mg/L
TVO	430 ug/L
Acetone	200 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benezene	< 1 ug/L
Toluene	< 1 ug/L
Xylene	5 ug/L
Isopropanol	44 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	4.05±0.059E+04 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.8	5.8	-396	356	125	3.6
9/13/82	19.9	6.0	-308	475	130	6.0

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WM-0055

Alkalinity Hydroxide	< 1 mgCaCO$_3$/L
Alkalinity Bicarbonate	16 mgCaCO$_3$/L
Alkalinity Carbonate	< 1 mgCaCO$_3$/L
Total Iron	< 0.2 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	1 mg/L
TVO	9 ug/L
Acetone	< 10 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	5 ug/L
Xylene	2 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethane	< 1 ug/L
Tritium	1.27$\pm$0.013E+05 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.3	6.6	+345	86	33	6.5
9/13/82	20.6	6.0	+436	115	31	6.6

WM-0056

Alkalinity Hydroxide	< 1 mgCaCO$_3$/L
Alkalinity Bicarbonate	11 mgCaCO$_3$/L
Alkalinity Carbonate	< 1 mgCaCO$_3$/L
Total Iron	1 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	1 mg/L
TVO	35 ug/L
Acetone	< 10 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	8 ug/L
Xylene	1 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	1.12$\pm$0.01E+05 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.3	5.9	+ 80	103	30	3.9
9/13/82	20.2	5.5	+236	50	27	3.0

WM-0057

Alkalinity Hydroxide	< 1 mgCaCO$_3$/L
Alkalinity Bicarbonate	< 1 mgCaCO$_3$/L
Alkalinity Carbonate	< 1 mgCaCO$_3$/L
Total Iron	< 0.2 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	24 mg/L
TVO	14 ug/L
Acetone	5 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	< 1 ug/L
Xylene	< 1 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	9.35±0.094E+04 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.7	4.4	+429	16	9	7.0
9/13/82	20.6	5.2	+380	37	15	3.1

WM-0070

Alkalinity Hydroxide	< 1 mgCaCO$_3$/L
Alkalinity Bicarbonate	8 mgCaCO$_3$/L
Alkalinity Carbonate	< 1 mgCaCO$_3$/L
Total Iron	0.19 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	3 mg/L
TVO	6 ug/L
Acetone	< 20 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	1 ug/L
Xylene	< 1 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	2.04±0.41E+02 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

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WM-0070 (Continued)

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.2	5.8	+416	49	22	8.3
9/13/82	19.0	5.0	+348	25	22	7.8

WM-0071

Alkalinity Hydroxide	< 1 mg$CaCO_3$/L
Alkalinity Bicarbonate	4 mg$CaCO_3$/L
Alkalinity Carbonate	< 1 mg$CaCO_3$/L
Total Iron	< 0.1 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	< 1 mg/L
TVO	4 ug/L
Acetone	< 20 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	1 ug/L
Xylene	< 1 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	5.62±0.35E+02 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.2	5.1	+453	28	13	9.2
9/13/82	19.0	4.5	+369	14	12	9.5

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WM-0072

Alkalinity Hydroxide	< 1 $mgCaCO_3/L$
Alkalinity Bicarbonate	24 $mgCaCO_3/L$
Alkalinity Carbonate	< 1 $mgCaCO_3/L$
Total Iron	0.4 mg/L
Ferrous Iron	0.4 mg/L
TOC	< 1 mg/L
TVO	< 1 ug/L
Acetone	< 10 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	< 1 ug/L
Xylene	< 1 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethane	< 1 ug/L
Tritium	6.36±0.38E+02 pCi/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.0	6.2	+393	111	42	3.1
9/13/82	18.9	5.4	+329	58	36	2.1

WM-0073

Alkalinity Hydroxide	< 1 $mgCaCO_3/L$
Alkalinity Bicarbonate	25 $mgCaCO_3/L$
Alkalinity Carbonate	15 $mgCaCO_3/L$
Total Iron	0.7 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	4 mg/L
TVC	3 ug/L
Acetone	< 20 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	1 ug/L
Toluene	2 ug/L
Xylene	< 1 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	4.52±0.28E+02 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.6	10.1	+240	207	100	0.7
9/13/82	21.3	9.1	+248	120	60	4.8

WM-0074

Alkalinity Hydroxide	< 1 mgCaCO$_3$/L
Alkalinity Bicarbonate	28 mgCaCO$_3$/L
Alkalinity Carbonate	20 mgCaCO$_3$/L
Total Iron	1.9 mg/L
Ferrous Iron	0.6 mg/L
TOC	66 mg/L
TVO	26 ug/L
Acetone	21 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	2 ug/L
Xylene	< 1 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	1.51±0.078E+03 pCi/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.4	10.2	+221	139	48	7.0
9/13/82	21.4	9.3	+257	88	55	8.8

WM-0075

Alkalinity Hydroxide	< 1 mgCaCO$_3$/L
Alkalinity Bicarbonate	24 mgCaCO$_3$/L
Alkalinity Carbonate	< 1 mgCaCO$_3$/L
Total Iron	< 0.2 mg/L
Ferrous Iron	< 0.2 mg/L
TOC	2 mg/L
TVO	20 ug/L
Acetone	< 10 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	< 1 ug/L
Xylene	< 1 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dicloroethylene	< 1 ug/L
Tritium	2.41±0.044E+04 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.6	6.8	+ 33	304	100	4.0
9/13/82	19.8	6.1	+224	131	60	3.6

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WM-0089

Alkalinity Hydroxide	< 1 $CaCO_3$/L
Alkalinity Bicarbonate	< 1 $CaCO_3$/L
Alkalinity Carbonate	< 1 $CaCO_3$/L
Total Iron	0.82 mg/L
Ferrous Iron	<0.2 mg/L
TOC	4 mg/L
TVO	40 ug/L
Acetone	38 ug/L
1,1,1 Trichloroethane	< 1 ug/L
Benzene	< 1 ug/L
Toluene	1 ug/L
Xylene	< 1 ug/L
Isopropanol	< 20 ug/L
Ethylbenzene	< 1 ug/L
Dichloroethylene	< 1 ug/L
Tritium	8.42±0.49E+02 pCi/L
EDTA	<2 mg/L
DTPA	<5 mg/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
7/7/82	19.9	4.7	+253	41	14	4.8
9/13/82	19.9	4.7	+234	18	15	1.1

WB-0101

Ferrous Iron	<0.01	mg/L
Iron	0.1	mg/L
Alkalinity, Hydroxide	< 2	mgCaCO$_3$/L
Alkalinity, Bicarbonate	14	mgCaCO$_3$/L
Alkalinity, Carbonate	< 2	mgCaCO$_3$/L
Alkalinity, Total	14	mgCaCO$_3$/L
TOC	2	mg/L
Acetone	4	ug/L
Benzene	< 1	ug/L
Toluene	2	ug/L
TVO	6	ug/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
3-22-83	18.1	6.0	+332	39	35	--

WB-0201

Ferrous Iron	<0.01	mg/L
Iron	< 0.1	mg/L
Alkalinity, Hydroxide	< 2	mgCaCO$_3$/L
Alkalinity, Bicarbonate	< 2	mgCaCO$_3$/L
Alkalinity, Carbonate	< 2	mgCaCO$_3$/L
Alkalinity, Total	< 2	mgCaCO$_3$/L
TOC	3	mg/L
Acetone	2	ug/L
Benzene	< 1	ug/L
Toluene	< 1	ug/L
TVO	2	ug/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
3-22-83	17.1	4.3	+399	16	20	--

WB-0301

Ferrous Iron	<0.01	mg/L
Iron	0.3	mg/L
Alkalinity, Hydroxide	28	mgCaCO$_3$/L
Alkalinity, Bicarbonate	< 2	mgCaCO$_3$/L
Alkalinity, Carbonate	47	mgCaCO$_3$/L
Alkalinity, Total	75	mgCaCO$_3$/L
TOC	3	mgCaCO$_3$/L
Acetone	2	ug/L
Benzene	< 1	ug/L
Toluene	< 1	ug/L
TVO	2	ug/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
3-22-83	18.1	6.0	+332	39	35	--

[illegible]

WB-0401

Ferrous Iron	<0.01	mg/L
Iron	0.1	mg/L
Alkalinity, Hydroxide	< 2	$mgCaCO_3/L$
Alkalinity Bicarbonate	35	$mgCaCO_3/L$
Alkalinity, Carbonate	< 2	$mgCaCO_3/L$
Alkalinity Total	35	$mgCaCO_3/L$
Total Org. Carbon	2	mg/L
Acetone	2	ug/L
Toluene	1	ug/L
Benzene	< 1	ug/L
TVO	3	ug/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
3-22-83	17.4	7.1	+276	119	90	--

WB-0501

Ferrous Iron	<0.01	mg/L
Iron	< 0.1	mg/L
Alkalinity, Hydroxide	< 2	$mgCaCO_3/L$
Alkalinity, Bicarbonate	< 2	$mgCaCO_3/L$
Alkalinity, Carbonate	< 2	$mgCaCO_3/L$
Alkalinity, Total	< 2	$mgCaCO_3/L$
Total Org. Carbon	2	mg/L
Acetone	< 1	ug/L
Benzene	< 1	ug/L
Toluene	11	ug/L
TVO	11	ug/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
3-22-83	18.1	3.9	+371	34	29	--

WB-0601

Ferrous Iron	<0.01	mg/L
Iron	< 0.1	mg/L
Alkalinity, Hydroxide	< 2	$mgCaCO_3/L$
Alkalinity, Bicarbonate	< 2	$mgCaCO_3/L$
Alkalinity, Carbonate	< 2	$mgCaCO_3/L$
Alkalinity, Total	< 2	$mgCaCO_3/L$
Total Org. Carbon	2	mg/L
Acetone	< 1	ug/L
Benzene	< 1	ug/L
Toluene	< 1	ug/L
TVO	< 1	ug/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
3-22-83	16.3	4.4	+375	10	15	--

WB-0701

Ferrous Iron	<0.01 mg/L
Iron	0.4 mg/L
Alkalinity, Hydroxide	< 2 $mgCaCO_3/L$
Alkalinity, Bicarbonate	28 $mgCaCO_3/L$
Alkalinity, Carbonate	< 2 $mgCaCO_3/L$
Alkalinity, Total	28 $mgCaCO_3/L$
Total Org. Carbon	2 mg/L
Acetone	< 1 ug/L
Benzene	< 1 ug/L
Toluene	< 1 ug/L
TVO	< 1 ug/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
3-22-83	18.3	7.2	+287	69	45	--

WB-0801

Ferrous Iron	< 0.1 mg/L
Iron	< 0.1 mg/L
Alkalinity, Hydroxide	< 2 $mgCaCO_3/L$
Alkalinity, Bicarbonate	4 $mgCaCO_3/L$
Alkalinity, Carbonate	< 2 $mgCaCO_3/L$
Alkalinity, Total	4 $mgCaCO_3/L$
TOC	1 mg/L
Acetone	< 1 mg/L
Benzene	< 1 ug/L
Toluene	6 ug/L
TVO	6 ug/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
3-22-83	18.1	5.4	340	25	23	--

WB-0901

Ferrous Iron	< 0.1 mg/L
Iron	< 0.1 mg/L
Alkalinity, Hydroxide	< 2 $mgCaCO_3/L$
Alkalinity, Bicarbonate	19 $mgCaCO_3/L$
Alkalinity, Carbonate	< 2 $mgCaCO_3/L$
Alkalinity, Total	19 $mgCaCO_3/L$
TOC	2 $mgCaCO_3/L$
Acetone	4 ug/L
Benzene	< 1 ug/L
Toluene	2 ug/L
TVO	6 ug/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
3-22-83	17.0	7.5	243	36	30	--

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WB-1001

Ferrous Iron	<	0.1 mg/L
Iron	<	0.1 mg/L
Alkalinity, Hydroxide	<	2 mgCaCO$_3$/L
Alkalinity Bicarbonate		7 mgCaCO$_3$/L
Alkalinity Carbonate		38 mgCaCO$_3$/L
Alkalinity, Total		45 mgCaCO$_3$/L
Acetone		5 ug/L
Benzene	<	1 ug/L
Toluene		4 ug/L
TVO		9 ug/L

DATE	TEMP.	pH	ORP	COND.	DS	DO
3-22-83	17	10.2	147	79	11	--

WO-0007

Ferrous Iron	< 0.1	mg/L
Iron	< 0.1	mg/L
Alkalinity, Hydroxide	< 2	mgCaCO$_3$/L
Alkalinity, Bicarbonate	52	mgCaCO$_3$/L
Alkalinity, Carbonate	< 2	mgCaCO$_3$/L
Alkalinity, Total	52	mgCaCO$_3$/L
Total Org. Carbon	1	mg/L
Acetone	< 1	ug/L
Benzene	< 1	ug/L
Toluene	< 1	ug/L
TVO	< 1	ug/L

WO-0023

Ferrous Iron	< 0.1	mg/L
Iron	0.6	mg/L
Alkalinity, Hydroxide	< 2	mgCaCO$_3$/L
Alkalinity, Bicarbonate	23	mgCaCO$_3$/L
Alkalinity, Carbonate	< 2	mgCaCO$_3$/L
Alkalinity, Total	23	mgCaCO$_3$/L
Total Org. Carbon	2	mg/L
Acetone	< 1	ug/L
Benzene	< 1	ug/L
Toluene	6	ug/L
TVO	6	ug/L

WO-0024

Ferrous Iron	< 0.1	mg/L
Iron	< 0.1	mg/L
Alkalinity, Hydroxide	< 2	mgCaCO$_3$/L
Alkalinity, Bicarbonate	7	mgCaCO$_3$/L
Alkalinity, Carbonate	< 2	mgCaCO$_3$/L
Alkalinity, Total	7	mgCaOC$_3$/L
Total Org. Carbon	4	mg/L
Acetone	5	ug/L
Benzene	< 1	ug/L
Toluene	2	ug/L
TVO	7	ug/L

WO-0026

Ferrous Iron	< 0.1	mg/L
Iron	0.2	mg/L
Alkalinity, Hydroxide	< 2	mgCaCO$_3$/L
Alkalinity, Bicarbonate	59	mgCaCO$_3$/L
Alkalinity, Carbonate	< 2	mgCaCO$_3$/L
Alkalinity, Total	59	mgCaCO$_3$/L
Total Org. Carbon	4	mg/L
Acetone	< 1	ug/L
Benzene	< 1	ug/L
Toluene	2	ug/L
TVO	2	ug/L

WO-0027

Ferrous Iron	< 0.1	mg/L
Iron	0.1	mg/L
Alkalinity, Hydroxide	< 2	mgCaCO$_3$/L
Alkalinity, Bicarbonate	22	mgCaCO$_3$/L
Alkalinity, Carbonate	< 2	mgCaCO$_3$/L
Alkalinity, Total	22	mgCaCO$_3$/L
TOC	2	mg/L
Acetone	< 1	ug/L
Benzene	< 1	ug/L
Toluene	< 1	ug/L
TVO	< 1	ug/L

WO-0028

Ferrous Iron	< 0.1	mg/L
Iron	< 0.1	mg/L
Alkalinity, Hydroxide	< 0.2	mdCaCO$_3$/L
Alkalinity, Bicarbonate	2	mgCaCO$_3$/L
Alkalinity, Carbonate	< 2	mgCaCO$_3$/L
Alkalinity, Total	2	mgCaCO$_3$/L
Total Org. Carbon	5	mg/L
Acetone	< 1	ug/L
Benzene	< 1	ug/L
Toluene	2	ug/L
TVO	2	ug/L

WO-0029

Ferrous Iron	0.1	mg/L
Iron	4.9	mg/L
Alkalinity, Hydroxide	< 2	mgCaCO$_3$/L
Alkalinity, Bicarbonate	10	mgCaCO$_3$/L
Alkalinity, Carbonate	< 2	mgCaCO$_3$/L
Alkalinity, Total	10	mgCaCO$_3$/L
Total Org. Carbon	2	mg/L
Acetone	< 1	ug/L
Benzene	< 1	ug/L
Toluene	5	ug/L
TVO	5	ug/L

WO-0032

Ferrous Iron	< 0.1	mg/L
Iron	6.1	mg/L
Alkalinity, Hydroxide	< 2	mgCaCO$_3$/L
Alkalinity, Bicarbonate	16	mgCaCO$_3$/L
Alkalinity, Carbonate	< 2	mgCaCO$_3$/L
Alkalinity, Total	16	mgCaCO$_3$/L
Total Org. Carbon	3	mg/L
Acetone	2	ug/L
Benzene	< 1	ug/L
Toluene	6	ug/L
TVO	8	ug/L

TYPE ANALYSIS	UNITS
Alkalinity Hydroxide	mg$CaCO_3$/L
Alkalinity Bicarbonate	mg$CaCO_3$/L
Alkalinity Carbonate	mg$CaCO_3$/L
Total Iron	mg/L
Ferrous Iron	mg/L
Total Organic Carbon (TOC)	mg/L
Ethylenediamine Tetraacidic Acid (EDTA)	mg/L
Pentetic Acid (DTPA)	mg/L
Total Volatile Organics (TVO)	ug/L
Acetone	ug/L
1,1,1-Trichloroethane	ug/L
Benzene	ug/L
Toluene	ug/L
Xylene	ug/L
Isopropanol	ug/L
Ethylbenzene	ug/L
Dichloroethylene	ug/L

APPENDIX F

PROPOSED EPA DRINKING WATER STANDARDS

VOLATILE SYNTHETIC ORGANIC CHEMICALS

PROPOSED NATIONAL PRIMARY DRINKING WATER REGULATIONS;
VOLATILE SYNTHETIC ORGANIC CHEMICALS

(Federal Register, Vol. 50, No. 219, November 13, 1985, 46902-46933)

Contaminant	Maximum Contaminant Level (ug/l)
trichloroethylene	5
carbon tetrachloride	5
vinyl chloride	1
1,2-dichloroethane	5
benzene	5
1,1-dichloroethylene	7
1,1,1-trichloroethane	200
p-dichlorobenzene	750

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NRC FORM 335
(2-84)
NRCM 1102,
3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

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Radioactive Waste Disposal Sites

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13. ABSTRACT (200 words or less)

The NRC is investigating appropriate regulatory options for disposal of low-level radioactive waste containing nonradiological hazardous constituents, as defined by EPA regulations. Standard EPA/RCRA procedures to determine hazardous organics, metals, indicator parameters, and general water quality are applied to samples from groundwater monitoring wells at two commercial low-level radioactive waste disposal sites. At the Sheffield, IL site (non-operating) several typical organic solvents are identified in elevated concentrations in onsite wells and in an offsite area exhibiting elevated tritium concentrations. At the Barnwell, SC site (operating), only very low concentrations of three organics are found in wells adjacent to disposal units. Hydrocarbons associated with petroleum products are detected at both sites. Hazardous constituents associated with previously identified major LLW mixed waste streams, toluene, xylene, chromium, and lead are at or below detection limits or at background levels in all samples. Review of previously collected data also supports the conclusion that organic solvents are the primary nonradiological contaminants associated with LLW disposal.

14 DOCUMENT ANALYSIS - a KEYWORDS/DESCRIPTORS
low-level waste, radioactive mixed waste, land disposal, organics, toluene, xylene, lead, tritium, groundwater contamination, Sheffield, Illinois, Barnwell, South Carolina

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